



CONSIDERING
RESEARCH

PROCEEDINGS OF THE ARCC
SPRING RESEARCH CONFERENCE

ARCHITECTURAL RESEARCH
CENTERS CONSORTIUM

Proceedings of the 2011 ARCC Spring Research Conference
Architectural Research Centers Consortium Considering Research
Reflecting upon current themes in Architectural Research

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CONSIDERING
RESEARCH:

REFLECTING
UPON CURRENT
THEMES IN
ARCHITECTURAL
RESEARCH

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EDITORS:
PHILIP PLOWRIGHT
BRYCE GAMPER

C O N S I D E R I N G
R E S E A R C H

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INTRODUCTION

The ARCC Spring Architectural Research Conference series is, in my mind, an important venue for the architectural community. It is important due to the focus that the ARCC brings into disciplinary discussions and follows these up in two ways.

First, the conference series maintains a very clear sense of responsibility to consider core architectural concerns without marginalizing or accentuating any particular focus. As it was communicated to me by the ARCC Board, it is the belief of the ARCC that any one subject matter within architecture is as important as any other, and the richness that is architecture cannot exist without this layered understanding of our discipline. In an ARCC conference, studies of acoustics in terms of spatial quality are situated next to explorations of metrics of sustainability or the application of philosophical positions in considering architectural design frameworks. Marginalizing any of these introduces nothing but paucity in architectural design and the built environment.

The second factor of importance tempers this breadth of content and introduces a clear position which exemplifies the ARCC. While all and any topics within the architectural domain are considered, they are considered in a very particular way. The biannual Spring Conference is a conference dedicated to *architectural research*. This means that you will not find personal musings or descriptions of a discrete and non-transferable project (one-off success case), opinion rather than crafted argument, or case-study without analysis and projection. Neither will you find discussions of teaching practices within architecture for while these are critical explorations, they are focused on the scholarship of education rather than the discipline of architecture. You *will* find controversial or unpopular positions supported in the conference, as long as the scholarship is rigorous and methodology clearly visible.

In the spirit of both disciplinary inquiry and research, we would like to consider the substantial developments in technology, public consciousness and economic pressures in the architectural research community of the past decades as the focus for the ARCC 2011 conference. The rise of ethical awareness, social networking, sustainability and the green movement, changes in manufacturing and marketing, changing energy codes, shifting populations, and globalization, to name a few issues, have all brought pressure to bear on interests within the research community. There is, however, a substantial lack of assessment of the impact and relevance of these contemporary paradigms. The absence of comprehensive reflection on the usefulness and long-term relevance of our research is combined with two current critiques. The first is an internal disciplinary voice that positions much of architecture as having a tendency to distract itself, focusing massive amounts of time and energy on problems which are self-fabricated while ignoring more fundamental research concerns. The second is a rising dialogue in other fields which calls many of our current architectural processes into question by defining them as too narrowly focused, neglecting many social, cultural, and political considerations. Both these critiques seem to call for a more holistic approach, stressing multi-scalar approaches, interdisciplinary collaboration, and international cooperation.

There are many questions that arise when considering existing frameworks, scales, practices and processes in architectural research. At the core, there are questions of how can research help us reflect on various contemporary environmental, sustainable; social, political, formal, and psychological paradigms. What are the impacts of these paradigms? Have they addressed what they claimed they intend to address? Do they do what they say they do? Where do they stand and what effect might they have? It is time to reflect on our practices and map critical issues and processes for the coming decades.

In the following pages, you will meet research papers which explore questions such as:

- How can research help us reflect on various contemporary environmental, sustainable, social, political, formal, and psychological paradigms?
- What are the impacts of these paradigms?
- Have they addressed what they claimed they intend to address?

- Do they do what they say they do?
- Where do they stand and what effect might they have?
- How should we consider research as an integrated part of our practice and discipline?

As a note of organization, the conference call was divided into three major categories. The intention was to provide some focus and (attempt to) defy sub-disciplinary categorization. These categories were ‘on approaches’, ‘on measurement’ and ‘on relevance’. As you can see from the details following, the conference’s Organizing and Advisory Committees gathered a series of subtopics in each of the categories, purposely stated to be intra- and inter-disciplinary in focus.

‘On Approaches’ was conceived, in general terms, to include the following: research on conceptual frameworks and their effect on forms of collaboration; ecology, sustainability, and changing societal and political economies; the role and use of philosophy in architectural research; digital approaches and the ‘real world’; and alternative approaches in research methods.

‘On Measurement’, in contrast, dealt with any and all metrics whether applied to energy, temperature, quality or beauty. The questions and focuses provided by the Conference committees included: quantifying sustainability, looking to see if we using the correct measures; what is performance, approaches to energy, occupation, consumption and reuse; integrating the human dimension in architectural research; social environment: what lessons can architectural research learn from the social sciences; and construction processes and fabrication, their metrics, effects and priorities.

Finally, ‘On Relevance’ inquired about meaning and “what matters” particularly in the aspect of cross-disciplinary concerns. Focuses included addressing disenfranchisement (technological and social approaches); the interaction of allied disciplines in architecture and architectural education and whether they are doing anything; questions around ethics which were tagged with the terms responsibility, activism and research; pure research, applied research and the market; and identifying or assessing emerging trends and fields in architectural research.

The conference wouldn’t have been possible without the continued support of both the Board of Directors of ARCC, lead by Dr. Michael Kroelinger, and the generosity of the College of Architecture and Design at Lawrence Tech, under the direction of Dean Glen LeRoy. I would like to offer my heartfelt thanks for both of these groups, the authors (who suffered from too many emails from me) and all the various individuals who have selflessly donated their time, energy and intellect. A special note needs to be added for our late colleague, Dr. Virginia North. Virginia was the driving force behind Lawrence Tech’s involvement in the ARCC and organized the application to host the 2011 ARCC conference. With great sadness, her life was unexpectedly cut off before she could see it happen.

If, at the very least, this conference begins a series of interactions that leads to critical disciplinary discussions, allows a small moment of insight on our own research agendas, or formulates a single question to frame the next decade for the participants, I believe it will have been a successful event. All in all, the ARCC conference series is one of the few venues in which individuals who are invested in the discipline of architecture can gather in an inter-institutional format and talk *strictly* about architecture. Hopefully this year’s conference will be no different.

Sincerely,
Philip Plowright, Chair
ARCC 2011 Architectural Research Conference

ON APPROACHES

Appropriating space in an assisted living residence. On architecture and elderly frail people's spatial use

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ABSTRACT:

An assisted living residence with identical layout for two non-special care units (NSCU) and two special care units (SCU), designated as an exemplary model, was used as a test bed for this study on elderly people's spatial appropriation of communal space. Using qualitative research methods (interviews, participatory observations, TESS-NH), eighteen residents' spatial usages were mapped. Thereafter, ten residents with dominantly somatic diseases were interviewed as to their appreciation and use of the communal space. Using the same qualitative interviewing guide, three staff members were interviewed in relation to eight persons with dementia. The collected data was analyzed by use of the Lynchian imageability pentad. Depending on the residents' age-related problem and the specific conditions in situ, the elderly persons' spatial usages of the individual unit could be described graphically in a mental map. A place-making process was the motivating force behind this spatial appropriation, conditioned by age-related problems. At the NSCUs, the elderly spurred this process themselves by developing a pattern consisting of movements towards places open for activities, contact and social interaction. On the other hand, at the SCUs, the dementia diagnosis affected this pattern. At these units, the movements and the places depended upon the elderly person's dependency on the staff for self-affirmation and calm. The overarching conclusion of this study is that an appropriate architectural space for an assisted living residence reinforces the place-making process, either the one of the elderly frail people, or the one staged by the staff. Besides general requirements of accessibility, functionality, and usability, this type of architecture needs to employ spatial elements that constitute a communal space that fosters an appropriative process based on the sensuous stimulation exploitable at a particular place. Thus, architecture acquires a supportive quality that nourishes the perceived homeliness by the elderly people themselves, or as staged by the staff.

KEY WORDS: assisted living architecture, architectural design, age-related problems, appropriation, mental maps.

INTRODUCTION

In the context of an assisted living residence, *"the most light-hearted becomes saddened"* (Balzac, 1835, p. 5), since this is often a place *"where the sound of a vehicle becomes an event"* and *"the walls smell like prison"* (Ibid., p. 5). It embodies a *"materialistic concretization of ideas and beliefs"* (Balzac, 1842, p. 9) about the appropriate space for aging. The social relationship between residents and staff, and the separation between communal and private space are defined by guidelines for the architectural space. These guidelines for the optimal interaction between aging, age-related problems and care philosophies have a certain similarity with a lost art that prior to the photographic revolution consisted of a meticulous description of human artifacts, usages and built space, *"l'architectonographie"* (Mimouni, 1999, p. 88). (Mimouni, 1999, p. 88). To go beyond the existential dilemmas of aging, this paper tries to reconnect to this old tradition, and will explore elderly people's use of communal space in a Swedish assisted living residence, and their relationship with architectural space.¹

1.0 BACKGROUND

Natural processes slacken and make an elderly person cognitively slower to perceive architectural space (Johansson, 2001). Still, this process is highly individual, and dominantly permits an aging in place. A significant feature of the aging process is that the individual use of space shrinks and becomes restricted to the most immediate environment close to home (Rowles, 1993). At the same

time, in Western developed countries, place identity is a vital component of self-identity for elderly people (Peace, Holland, & Kellaher, 2005). Thus, the environmental provision of autonomy and independence as well as the resident's individual choice are core criteria for the design of assisted living residences in most Western countries (Brent, 1999; Pynoos & Regnier, 1991; Regnier, 2002; Schwarz, 1999). In some cases, the aging process leads to cognitive and functional impairments that cause a changed behavior and a distorted visuo-spatial thinking (Hoof, Kort, Duijnste, Rutten, & Hensen, 2010; Kolb & Whishaw, 2002; Robinson, 2002; Schreder et al., 2007). In such a case, an apartment in an assisted living residence² becomes necessary. Swedish assisted living residences accommodate approximately 95,200 elderly persons with a high degree of assistance and care in order to uphold activities in daily living (ADL) (NBHW, 2008). There is a recommendation that for the architecture for an assisted living residence to be ideal it must meet a list of over a hundred various spatial criteria (Regnier, 2002). Of particular importance is the provision of small spaces suitable for spontaneous sojourns for a group of two to three persons, thereby allowing for the creation of new social arenas inside the residence, since the aging process tends to narrow the individual social network (Ibid). In the context of elderly people suffering from dementia, space for wandering is required so as to ease the corporeal sensation of worry that the disease induces (Dehan, 1997, 2007). In contrast to these requirements based on the human aging process, the assisted living residence is subject to a societal interest, that disarms innovative architectural thinking and promotes standardization (Schwarz, 1997). The resultant impact is normative guidelines that aim to optimize the area of the resident's individual space and the one of the residents' communal space. The probable reason for this regulatory force can be found in the old origins of the modern social work for frail people in the former poor relief aid (Andersson, 2005b; Laws, 1997).

The architectural design defines a spatial choreography, an interior movement and a relation towards the exterior space, and establishes a staging of the architectural space (Bergström, 1996). Still, in the case of indoor architectural space, few studies have been performed other than those with a focus on architecture generally acknowledged as exemplary (Canter, 1991). When a gerontological angle is introduced in the context of human interactions with architecture, the question of aging, place, and space becomes a multi-disciplinary field of research. The architectural design has been attributed with a therapeutic dimension (Cutler, 2007; Day, Carreon, & Stump, 2000; Rioux, 2003; Teresi, Holmes, & Ory, 2000) that may result in a supportive environment for elderly people with extensive need of daily assistance (Devlin & Arneill, 2003). Both international and Swedish experience- or research-based findings have emphasized the significance of the so-called homeliness in the assisted living setting (Altman_Klein, 1993; Lindström & Åhnlund, 1982; NBHW, 1983). Architectural research suggests that an elderly person's adjustment to the assisted living residence depends on a successful transition from the previous domicile to the new environment (Toyama, 1988). Spatial interventions in housing for elderly frail people have shown that the elderly person's individual experience of the interior setting is dovetailed with coping strategies and nutritional status (Elmståhl, 1987; Küller, 1991). A homelike environment exploits spatial features that are present in the ordinary domicile. The architectural space and its artifacts are powerful components of the on-going resident-staff agency in an assisted living residence (Nord, 2010).

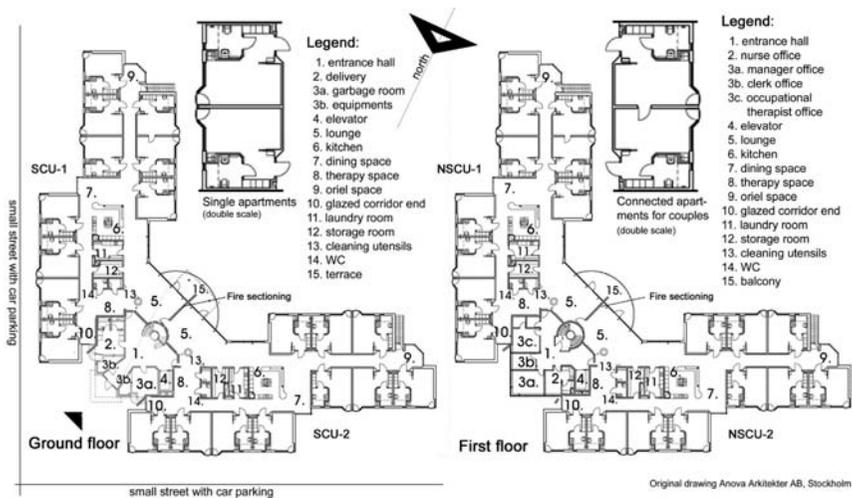
1.1 AIMS AND WORKING HYPOTHESIS

The objective of this study is to explore the architectural space of an assisted living residence with a post-occupancy evaluative approach. The residence has been designated as an exemplary model of assisted living. This study has two explicit aims: Firstly, to explore elderly frail people's spatial uses of communal space in terms of movements and sojourns in an assisted living setting. Secondly, to identify significant architectural features active in this process. This study has been guided by the working hypothesis that the individual's appropriation of the communal space of an assisted living residence is an outcome of the degree of homeliness that is attributable to the interior landscape and that the elderly person experiences. Nonetheless, the elderly person's perception of homelike environmental features is conditioned by his or her individual health status, either affected by dementia or somatic disorders.

1.2 THEORETICAL FRAMEWORK

In this paper, architecture is understood as any man-made construction and a scalable reflection of human existence (Norberg-Schulz, 1971). The interest of this paper pertains to the individual appropriation of communal space in a residence for assisted living (Lefebvre, 1985). It is a matter of a place-making process (Rosel, 2003; Rowles, 1993, 2000), where a personal attachment to a certain spatiality acquires an existential dimension, since space with its artifacts becomes an important *place* for a certain individual. Place identity is an important component of older people's self-identity (Peace et al., 2005; Smith, 2009). Contrary to the traditional view that the built space per se is a place (Tuan, 1977), this place-making is created through the rhythms of being, and place is constituted by dispersed pieces of architecture, or natural landscapes (Lefebvre, 1992). This paper embraces a transactional world view (Altman & Rogoff, 1987), where home is perceived as a holistic entity constituted by inter-related qualities of activities, physical settings, social interaction, and time. In turn, these qualities are assumed to be influenced by the cognitive and physical aging process of the residents (Lawton, 2000; Lawton & Simon, 1968). Given the implications of aging, namely dementia causing visuo-spatial problems or somatic multi-diagnoses affecting the body's locomotive functions, the architectural space of the assisted living residence constitutes a special kind of spatiality that bears on the quality of life (Pynoos & Regnier, 1991).

In the exteriority as well as in the interiority, the individual interpretive process of understanding the inner architectural space in terms of pleasant places to explore is active. Using sixty informants, the American urban planner Kevin Lynch explored three American cities, Boston, Jersey City and Los Angeles, by studying their "quality (...) of evoking a strong image of identity and structure in any given observer" (Lynch, 1960, p. 9). Lynch concluded that the urban landscapes could be transcribed into two-dimensional mental maps that described the city's character, its imageability (Ibid., p. 9). A Danish study, with a similar approach focusing on six residents' spatial usages of the Danish city Aalborg, concluded that these uses were mental maps that described a place-making process based on a list of personal priorities (Marling, 2003). In this paper, it is assumed that the Lynchian pentad of district-edge-landmark-node-path that is used to define the perceived imageability of the cityscape (Lynch, 1960), has an equivalent for the inner space. With reference to a study of an interior space, mental maps were used in order to describe the employees' spatial appropriation of the communal office space (Bodin Danielsson, 2005). The pentad of the exterior world was transferred to the interior one: 1) *landmarks*- the physical elements that created a strategic spatial foci for orientation;



Ros-Anders Assisted Living Residence

Figure 1: Ros-Anders assisted living residence, first floor and second floor. Approximate scale 1:800.

2) *paths*- the floor layout or the furnishing of space that defined how to traverse the environment; and 3) *nodes*- random junctions of intersecting paths. Given that the inner architectural space suffers from structural limitations, the Lynchian term district assuming an urban scale had to be translated by the term 4) *zone*, and fringe elements appeared as 5) *edges* between the zones detected (Ibid.).

2.0 METHODOLOGY

This study employed case study methodology (Yin, 2003) and a mixed method design (Creswell, Plano Clark, Gutmann, & Hanson, 2003). Heterogeneous research strategies were used in order to collect data and triangulate empirical findings (Onwuegbuzie & Johnson, 2008; Patton, 1997, 2002; Yin, 2003).

2.1 SETTING

This study was performed at a Swedish assisted living residence, Ros-Anders gården³, situated in a picturesque garden city in the municipality of Haninge, some 33 kilometers south of Stockholm. It has been designated as an exemplary model (Regnier, 2002). Inaugurated in 1999, the architecture features two special care units (SCU) with twenty apartments for elderly people with dementia on the first floor and, on the second floor, two non-special care units (NSCU) with apartments for the same number of persons with somatic diseases (Figure 1).⁴ Oriel windows in the gables create views of the surrounding environment, and there is a minimum of enclosing walls. Each unit has an individual kitchen.⁵ A locking keypad regulates passages to and from the unit. The observations were performed during the period June to September 2004, this particular summer with a very high temperature, often above 30 degrees Celsius before noon. Since the residence lacked air conditioning, this circumstance might have affected the elderly frail people's spatial usage of communal space that was more exposed to the sun.

2.2 SAMPLE

The sample was based on general information about the total population of 39 residents who lived at the residence at the time of the study. This was supplied by the staff. Twenty residents, six men and fourteen women, who lived on the first floor, the SCUs, were said to suffer from moderate to severe dementia. On the second floor, the NSCUs, nineteen residents, four men and fifteen women, experienced dominantly age-related functional disorders and other somatic problems. The staff reported that two of the residents, two women, suffered from a mild dementia. One of them was still fully able, while the other person was confined to a wheelchair. The average age of the residents of the SCUs was approximately eighty-one years old, whereas it was slightly higher, eighty-four years old at the NSCUs. However, the exact age and medical condition of each resident has not been possible to establish, since this was classified information that necessitated an approval from an ethical review board. The main focus of this study was elderly people's spatial interactions with architectural space, and therefore a descriptive statistical analysis of age and medical condition was deemed irrelevant for this type of study.⁶ Instead, the 39 residents formed the target population (n=39), but there were no inclusion criteria other than the resident's willingness to participate. Information about the resident's age, health and medical condition was attained to the extent the resident was willing to provide it.

2.3 RESEARCH METHODS

ENVIRONMENTAL ASSESSMENT: The Therapeutic Environment Screening Survey of Nursing Homes (TESS-NH) is an observational instrument that assumes the perspective of the elderly person with dementia and assesses the provision of safety, security, and physical health; orientation; provision of privacy, control, autonomy, and stimulation (both positive and negative); enhancement of socialization (social milieu); and personalization/familiarity (Sloane et al., 2002). In this study, the original American version of this instrument was used as a summary scale,⁷ along with the Special Care Unit Environmental Quality Scale (SCUEQS), a validated scale within the instrument. In both

cases, a high scoring indicates an appropriate environment for elderly frail people. A value of 0-10 points was assigned each item in the protocol. The evaluations were photo-documented, and aimed at corroborating the qualitative assessment of each unit. On average, the evaluation time per unit was 50 minutes. INTERVIEWS: A qualitative interviewing guide with three question themes was used in the interviews with ten residents and three staff members: a) the interviewee's background; b) views on the architecture of the residence and use of communal space; c) views on the care given (and in the case of interviews with a staff member questions pertaining to the residents). Twenty-six photographs were included in the guide that aimed to bring about a relaxed conversation that was adjusted to the interviewees' command of the language.¹⁰ The architect and the representative of the municipal administration for eldercare of Haninge municipality (AEHM) were also interviewed using the same interviewing guide. The interviews were transcribed. A recording (resident) or a printout (staff member or other) was sent to the interviewee. OBSERVATIONS: The participatory observations were coordinated with meal hours. The first observations took place between nine o'clock and noon, while the second occurred after lunch until 17.30 in the afternoon. A third segment occurred at 18.00-19.30 in the evening. During the observations, the author interacted with residents and staff.

First floor, 20 residents in all	
<p>SCU-1 10 RESIDENTS and 3 staff members (day time) All residents had dementia in an early phase. One resident one resident was aphasic but still able and fit. On the other hand, his personality had changed, and he had acquired a severe wandering behavior, and he constantly rearranged the interior decorating at the unit. This affected the other residents.</p> <p>Three women and one man regularly seen during the observation period.</p>	<p>SCU-2 10 RESIDENTS and 3 staff members (day time) All residents had dementia in a mid- or late phase. The residents were highly dependent on staff.</p> <p>Three men and one woman regularly seen during the observation period.</p>
Second floor, 19 residents in all	
<p>NSCU-1 10 RESIDENTS and 3 staff members (day time) The residents suffered mainly from somatic diseases (heart problems, brain tumor, equilibrium problems, age-related frailties), but two residents suffered from dementia in an early phase.</p> <p>Three women and two men regularly seen during the observation period.</p>	<p>NSCU-2 9 RESIDENTS and 2 staff members (day time) All residents have somatic diseases (aphasia, heart problems, equilibrium problems, age-related frailties)</p> <p>Three women and one man regularly seen during the observation period.</p>

Table 1: An approximate description of medical conditions found at the four units during the observation period in 2004

2.4 DATA COLLECTION PROCEDURE AND DATA ANALYSIS

Field notes summarized the events that took place, and the residents or staff members involved in these.¹¹ The study began with the TESS-NH assessment (the NSCUs in the morning on June 21st; the SCU-1 on June 22nd; the SCU-2 on June 28th, both were performed during the afternoon). The interviews started in July and ended in December 2004. The analysis of the collected data identified a variety of elderly person's usages of communal space, and conclusive mental maps of these uses were drawn for each unit using the pentad edge-landmark-node-path-zone. A preliminary report with seven fictitious characters and their use of the interior setting was written in 2005 (Andersson, 2005a), but circumstances postponed the full paper.^{12,13} The assisted living residence was revisited at random occasions in 2005, 2006 and 2007. Some of the usages identified seemed to persist although the original sample of residents had moved out or deceased and the new focus group for the entire residence had changed into being solely elderly people with dementia diagnoses.

2.5 ETHICAL CONSIDERATIONS

The ethical principles for research within the humanities and the social sciences have guided the study (Swedish_Research_Council, 2002). In February 2004, the residents, their relatives and the staff were informed about the project, and, prior to the observations, a letter that stated the aim of the project was sent out. A written statement of anonymity and confidentiality was handed over to the interviewee at the beginning of the interview.

3.0 RESULTS

This section is divided into three parts. The first part deals with the environmental assessment of the full residence and the separate units. The second part presents the characteristics of eighteen elderly persons who under fictitious names participated in the study. In two subsections, the elderly people's spatial use of the communal space is presented, one describing the conditions at the NSCUs, and the other one the conditions at the SCUs. In the third part, the elderly persons' spatial appropriations of the communal space of the NSCUs and the SCUs are transcribed into three separate mental maps, one for NSCU-1 and NSCU-2, and two for SCU-1 and SCU-2.

3.1 ENVIRONMENTAL ASSESSMENT

The architect said that the ambition for the communal space had been to create a "street character that passed through an urban landscape with a varying width". The architect argued that such an environment was supportive, since it reduced the "inhibiting sensation of entering an unknown room" (Karlsson, 2004). The representative from the AEHM said that that residence had turned out to be "a beautiful exterior and interior architecture" that "empowered the staff". Nevertheless, the representative said that the pleasant architectural space made the staff more inclined "to overlook the residence's shortcomings, since the residents seemed to be happy and thrive." Moreover, they had to make ad hoc adjustments in order to "compensate for the compact rationalized working environment" (Geijer, 2004): For instance, the handling of the residents' medicines and their individual journals had to be done on the kitchen counter for lack of working space. Furthermore, the representative explained that the interior decorating of each unit had been done independently by the staff themselves, as a part of a management strategy to improve the staff's adjustment to the new premises as well as to improve their performance as a care team. Each team had received the same amount of money, but they had chosen to employ it differently, some focusing on furniture and artifacts, and some focusing on textiles and curtains (Ibid.).

Computed for all four units, the mean TESS-NH summary score was 93.8 pts, lower than the mean value of the 53 referential American facilities, 95.5 pts, (Table 2). On the other hand the mean SCUEQS value, 26 points, was higher than the American referential values, 23.0 points. The SCU-2 was attributed the highest scores, 104.0 TESS-NH pts and 29.0 SCUEQS pts. The ranking order of the other units was unclear: According to the TESS-NH, the order was NSCU-2 (93 pts), and in a shared third position, NSCU-1 (89 pts) and SCU-1 (89 pts), while the SCUEQS gave the following ranking: NSCU-1 and NSCU-2 in second place (27 pts) and SCU-1 in third place (21 pts). Despite an extensive uniformity, the individual scores concerning environmental factors - maintenance, cleanliness, sensory stimulation, and noise-varied. Question 19 that dealt with the homelike appearance of communal space was important for the scope of this paper: The NSCU-1, NSCU-2, and SCU-2 were regarded somewhat homelike, while SCU-1 not at all. The overall assessment of the physical environment, question 32, on a ten point grading scale from unpleasant to pleasant, attributed a shared first place to NSUC-2 and SCU-2 (7 pts), the second place to NSCU-1 (4 pts) and the third place to SCU-1 (3 pts). This inconclusive outcome suggested that the individual ranking order of the units had to be correlated with the perceived completeness of the interior setting as a homelike environment. When combining this qualitative assessment with the interviews, the photographic documentation, and the TESS-NH instrument, the ranking order of the most appropriate unit turned out to be NSCU-2 in the first place, NSCU-1 in the second, and the SCU-2 in the third place. The SCU-1 was perceived as the least appropriate environment for elderly frail people.

3.2 PARTICIPANTS AND USE OF COMMUNAL SPACE

By use of observations and subsequent interviews, a sample of eighteen persons was established. On a regular basis, four female residents and four men were found in either of the communal spaces of the SCU-1 or the SCU-2, see table 2. These residents not only suffered from moderate to severe dementia, but they also had somatic diseases that added to their problems, especially at SCU-2. At the NSCU-1 and NSCU-2, six female residents and three male residents regularly used the

communal space for various purposes, (Table 3). These nine residents experienced mainly somatic problems although two also had a dementia diagnosis. A tenth resident, Felix confined to his bed, represented a special type of resident whose spatial use was limited due to architectural features. The interviews with the residents at the NSCU-1 and NSCU-2, and the staff at SCU-1 and SCU-2 revealed a key difference between residents. The residents with somatic diseases had consciously made the move from their previous apartments to the assisted living residence. Prior to moving, they had visited the residence, and they had chosen it due to its homelike appearance—the wooden flooring, the interior coloring, and the openness inside the communal space and towards the exterior. They liked the layout of the apartment. Still, Eugene remarked that a space for handicraft was missing, and Laure and Louise added that the home cooked meals had been a vital parameter for their decisions to move to the residence. The residents with dementia had been assigned an apartment at the residence by the AEHM, but they had not consciously moved to the assisted living. Adam, living at SCU-2, acted as if the unit was a barrack he recalled from his military service. Augustine and Beth, living at the NSCU-1 and both suffering from a mild dementia, described their apartments in relation to their previous experiences of work environments, offices and hospitals. They maintained their previous addresses. Thomas at SCU-1, had lived nearby the residence, and a relative took him regularly for walks in the neighborhood.

Therapeutic Goal, Domain, and Item Number		Ros-Andersgården Care Home, assessment June 2004						Referential values of American nursing homes n=53	SCUEQS
Item Description	Scoring Range	MEAN	SCU-1 21st June 04	SCU-2 21st June 04	NSCU-1 21st June 04	NSCU-2 21st June 04			
Privacy/ control/ autonomy									
1	Unit nursing station presence/ type	0-2	0.0	0.0	0.0	0.0	0.0	1.6	
2a	Nursing station for paperwork	0-1	0.0	0.0	0.0	0.0	0.0	0.7	
2b	Desk for paperwork	0-1	0.0	0.0	0.0	0.0	0.0	0.2	
2c	Combined work area for paperwork	0-1	1.0	1.0	1.0	1.0	1.0	0.0	
2d	Enclosed workroom, not a nursing sta	0-1	0.0	0.0	0.0	0.0	0.0	0.1	
3	Unit use as pathway between other ur	0-1	0.5	0.0	0.0	1.0	1.0	0.3	
4a	Residents eat on/ off unit	0-3	3.0	3.0	3.0	3.0	3.0	2.9	
4b	Formal activities on/ off unit	0-3	3.0	3.0	3.0	3.0	3.0	2.3	
4c	Residents bathe on/ off unit	0-3	3.0	3.0	3.0	3.0	3.0	2.9	
Outdoor Access									
26	Enclosed courtyard/	0-3	1.5	2.0	2.0	1.0	1.0	2.5	
27a	Attractiveness of courtyard	0-3	2.0	2.0	2.0	2.0	2.0	2.1	
27b	Courtyard is functional	0-3	3.0	3.0	3.0	3.0	3.0	1.9	
Privacy									
29a	Privacy curtain provides separation between beds in semiprivate rooms	0-9	9.0	9.0	9.0	9.0	9.0	1.0	
Safety/ security/ health/ exit control									
5a	Doors to rest of facility disguised	0-2	0.5	1.0	1.0	0.0	0.0	0.0	
5b	Doors to outside disguised	0-2	0.3	1.0	0.0	0.0	0.0	0.0	
6c	Doors are locked	0-1	1.0	1.0	1.0	1.0	1.0	0.8	
6d	Locking device triggered by approach	0-1	0.0	0.0	0.0	0.0	0.0	0.1	
6e	Lock disengaged by keypads/ switch	0-1	1.0	1.0	1.0	1.0	1.0	0.7	
6f	Locked at night/ during bad weather	0-1	0.0	0.0	0.0	0.0	0.0	0.0	
6g	Doors are alarmed	0-1	0.0	0.0	0.0	0.0	0.0	0.8	
6h	Alarm triggered by device worn by res	0-1	0.0	0.0	0.0	0.0	0.0	0.1	
6i	Alarm disengaged using keypad, card	0-1	0.0	0.0	0.0	0.0	0.0	0.5	
6j	Alarm sounds with all entries/ exits	0-1	0.0	0.0	0.0	0.0	0.0	0.2	
Maintenance									
7a	Maintenance of social spaces	0-2	1.8	1.0	2.0	2.0	2.0	1.7	SCUEQS
7b	Maintenance of halls	0-2	1.8	1.0	2.0	2.0	2.0	1.6	SCUEQS
7c	Maintenance of resident rooms	0-2	1.8	1.0	2.0	2.0	2.0	1.7	SCUEQS
7d	Maintenance of resident bathrooms	0-2	1.8	1.0	2.0	2.0	2.0	1.7	SCUEQS
Cleanliness									
8a	Cleanliness of social spaces	0-2	1.8	1.0	2.0	2.0	2.0	1.4	SCUEQS
8b	Cleanliness of halls	0-2	1.8	1.0	2.0	2.0	2.0	1.7	SCUEQS
8c	Cleanliness of resident rooms	0-2	1.8	1.0	2.0	2.0	2.0	1.8	
8d	Cleanliness of resident bathrooms	0-2	1.8	1.0	2.0	2.0	2.0	1.8	
9a	Bodily excretion odor in public areas	0-2	2.0	2.0	2.0	2.0	2.0	1.7	SCUEQS
9b	Bodily excretion odor in resident room	0-2	2.0	2.0	2.0	2.0	2.0	1.6	SCUEQS
Safety									
10a	Floor surface in social spaces	0-2	1.0	1.0	1.0	1.0	1.0	0.7	
10b	Floor surface in halls	0-2	1.0	1.0	1.0	1.0	1.0	0.8	SCUEQS
10c	Floor surface in resident rooms	0-2	1.0	1.0	1.0	1.0	1.0	0.6	
10d	Floor surface in resident bathrooms	0-2	1.0	1.0	1.0	1.0	1.0	1.3	
11a	Handrails in hallways	0-2	0.0	0.0	0.0	0.0	0.0	1.9	
11b	Handrails in bathrooms	0-2	0.0	0.0	0.0	0.0	0.0	1.4	

Stimulation/ Lighting									
12a	Light intensity in hallways	0-3	0.0	0.0	0.0	0.0	0.0	0.7	
12b	Light intensity in activity areas	0-3	1.3	1.0	2.0	1.0	1.0	1.2	SCUEQS
12c	Light intensity in resident rooms	0-3	1.0	1.0	1.0	1.0	1.0	0.6	SCUEQS
13a	Glare in hallways	0-2	0.0	0.0	0.0	0.0	0.0	1.0	
13b	Glare in activity areas	0-2	1.0	1.0	1.0	1.0	1.0	1.0	
13c	Glare in resident rooms	0-2	2.0	2.0	2.0	2.0	2.0	1.1	
14a	Lighting evenness in hallways	0-2	0.0	0.0	0.0	0.0	0.0	0.4	
14b	Lighting evenness in activity areas	0-2	1.0	1.0	1.0	1.0	1.0	0.7	
14c	Lighting evenness in resident rooms	0-2	1.0	1.0	1.0	1.0	1.0	0.2	
Visual/ tactile stimulation									
24a	Bedrooms with view of courtyard	0-3	3.0	3.0	3.0	3.0	3.0	5.2	
24b	Public areas with view of courtyard	0-3	3.0	3.0	3.0	3.0	3.0	2.7	
25a	Tactile stimulation opportunities	0-3	0.8	0.0	1.0	1.0	1.0	1.3	
25b	Visual stimulation opportunities	0-3	0.8	0.0	1.0	1.0	1.0	1.8	
Noise									
30	Status of television in main activity are	0-6	1.8	2.0	2.0	1.0	2.0	1.6	
31a	Residents screaming/ calling out	0-2	1.5	2.0	1.0	2.0	1.0	2.6	
31b	Staff screaming/ calling out	0-2	1.5	2.0	2.0	1.0	1.0	2.5	
31c	TV/ radio noise	0-2	1.3	2.0	2.0	0.0	1.0	1.9	
31d	Loud speaker/ intercom noise	0-2	1.0	2.0	2.0	0.0	0.0	2.7	SCUEQS
31e	Alarm/ call bell noise	0-2	1.0	2.0	2.0	0.0	0.0	2.5	
31f	Other machine noise	0-2	1.0	2.0	2.0	0.0	0.0	2.7	
Socialization/space/ seating									
17a	Path leads to dead ends	0-1	0.0	0.0	0.0	0.0	0.0	0.1	
17b	Path with places to sit	0-1	1.0	1.0	1.0	1.0	1.0	0.5	
18	Configuration of rooms of unit	0-2	1.0	1.0	1.0	1.0	1.0	0.2	
Personalization/ familiarity/homelikeness									
19	Public areas homelike	0-3	0.8	0.0	1.0	1.0	1.0	1.4	SCUEQS
20	Kitchen on the unit	0-2	1.0	1.0	1.0	1.0	1.0	0.9	
21	Pictures/ mementos in resident rooms	0-2	3.0	3.0	3.0	3.0	3.0	1.9	SCUEQS
22	Noninst. furniture in resident room	0-2	3.0	3.0	3.0	3.0	3.0	1.4	
23	Resident appearance	0-2	2.0	2.0	2.0	2.0	2.0	1.3	SCUEQS
Orientation/cuing									
28a1	Doors left open	0-1	0.0	0.0	0.0	0.0	0.0	0.8	
28b1	Resident's name on/ near door	0-1	1.0	1.0	1.0	1.0	1.0	0.2	
28c1	Current picture of resident	0-1	0.0	0.0	0.0	0.0	0.0	0.2	SCUEQS
28d1	Old picture of resident	0-1	0.0	0.0	0.0	0.0	0.0	0.0	SCUEQS
28e1	Objects of personal significance	0-1	0.0	0.0	0.0	0.0	0.0	0.0	
28f1	Room numbers	0-1	0.0	0.0	0.0	0.0	0.0	0.6	
28g1	Colour coding	0-1	0.0	0.0	0.0	0.0	0.0	0.0	
28a2	Bathr. door left open; toilet vis. fr. bed	0-1	0.0	0.0	0.0	0.0	0.0	0.0	
28b2	Bathr. door open; toilet not vis. fr. bed	0-1	0.0	0.0	0.0	0.0	0.0	0.3	
28c2	Bathr. door closed; picture or graphic	0-1	0.3	0.0	1.0	0.0	0.0	0.2	
28a3	Activity area visible from 50 % of resid	0-1	1.0	1.0	1.0	1.0	1.0	0.4	
28b3	Visual indicator of activity area visible	0-1	0.0	0.0	0.0	0.0	0.0	0.3	
28c3	Direction, identification sign visible froi	0-1	0.0	0.0	0.0	0.0	0.0	0.0	
Global rating									
32	Subjective rating of overall environmer	1-10	5.3	3.0	7.0	4.0	7.0	5.8	
total score TESS-NH			93.8	89.0	104.0	89.0	93.0	95.5	
total score SCUEQS			26.0	21.0	29.0	27.0	27.0	23.0	

Note. The SCUEQS is computed by adding the observed value for each variable. SCUEQS items are: 7a, 7b, 7c, 7d, 8a, 8b, 9a, 9b, 10b, 12b, 12c, 19, 20, 21, 23, 25, [a 0/1 variable which is 0 if 28c1 and 28d1 are both 0, and 1 if the value of either is 1], and 31d.

Table 2: The TESS-NH instrument used as a summery scale and SCUEQS scores (mean value's for the residence, and individual ones per unit). Main differences are presented in bold, italic style. Comparative values from 53 American nursing homes are added in the right column (Sloane et al., 2002).

fictive name	age	unit	diagnosis	type of interview	movement ¹		sojourns ²																		
					individual capacity to move	individual motive for movement	amount of staff assistance for movement	sensuous motive for place-making		emotional motive for place-making					personal activity involved in place-making										
								SL	EW	CL	CP	SI	Cs	H	R	RX	SA	T	SP	WT					
Augustine	80s	NSCU-1	NUD	PI	fully able	personal routine	ADL-m	1	1																
Beth	70s	NSCU-1	AD-II	PI	wheelchair	emotional worry	ADL-m			1	1														1 ³
Eugene	90s	NSCU-1	RA	PI	walker	personal routine	ADL-m	1	1																1
Felix	70s	NSCU-1	BT	PI	bed confined	staff related	ADL-e																		1 ⁴
Louise	70s	NSCU-1	ND	PI	wheelchair	staff related	ADL-e			1	1														1
Coralie	70s	NSCU-2	ND-A	SI	wheelchair	staff related	ADL-e	1	1																1
Jerome	70s	NSCU-2	HRP	PI	stick	personal routine	ADL-m	1	1																1
Julie	90s	NSCU-2	SAP	PI	walker	personal routine	ADL-m	1	1																1
Laure	80s	NSCU-2	HRP	PI	walker	personal routine	ADL-m	1	1																1
Philip	90s	NSCU-2	MAP	PI	fully able	personal routine	no ADL	1	1																1
Caroline	70s	SCU-1	AD-I	SI	fully able	personal routine	ADL-m	1	1																1
Esther	70s	SCU-1	AD-I	SI	fully able	personal routine	ADL-m	1	1																1
Sophie Thomas	70s	SCU-1	AD-I	SI	fully able	personal routine	ADL-m	1	1																1
Adam	70s	SCU-2	AD-II	PI	fully able	personal routine	ADL-m	1	1																1
Cesar	80s	SCU-2	AD-I	SI	fully able	personal routine	ADL-m	1	1																1
Flore	60s	SCU-2	AD-I	SI	Wheelchair	staff related	ADL-e	1	1																1
Raoul	80s	SCU-2	AD-III	SI	wheelchair	staff related	ADL-e	1	1																1

Abbreviations, diagnoses: AD-I = Alzheimer's disease, mild; AD-II = Alzheimer's disease, moderate; AD-III = Alzheimer's disease, severe; ADL-e = Activities in Daily Living, extensive need of assistance; ADL-m = Activities in Daily Living, moderate need of assistance; BT = brain tumor; HRP = heart-related problems; MAP = mild age-related problems; ND = neurological disease; NDA = neurological disease with apraxia; NUD = unclassified dementia; RA = rheumatoid arthritis; SAP = severe age-related problems of unidentified nature.

Abbreviations, other: PI = personal interview; SI = interview with staff in relation to resident; Note: 1) This information was obtained during the interview situation with the resident or the staff member, and correlated with the observations. In some cases, the staff added their knowledge of a particular resident's needs of assistance. 2) This information was obtained during the interview situation with the resident or the staff member, when he or she was asked to evaluate the inner architectural space of the residence. During this discussion, the informant was asked which places he or she would use during the day. This information was correlated with the data from the observations. 3) In Beth's case this refers to having a smoke. 4) In Felix' case, this refers to traditional feasts. 5) In Thomas' case, this refers to a state of anguish and worries. 6) In Flore's case, this refers to a state of anguish and worries.

Table 3: Informant characteristics and an overview of these elderly persons' movements and usages of the communal space of one unit or two units. This information was obtained by interviewing the participating residents and staff members. The information substantiated previous observations.

3.2.1 The communal space of the NSCUs

In 1999, when the residents moved in at the NSCUs, they still experienced good health. Eugene, Laure and Louise recalled happy birthday celebrations, crayfish-parties and Christmas Eves spent here. The door in the glass wall between the units was left open to promote this sense of social community. It still remained open, and both residents and staff members went from the NSCU-1 to enjoy the atmosphere at the NSCU-2. After breakfast or afternoon coffee, the staff helped Louise and the aphasic Coralie in their special wheelchairs, to enjoy the sunshine, a television series or other events in either of the lounge areas. In the afternoon, Jerome used to sit in the sofa in the lounge of the NSCU-2. Laure retained her habit to go there in the evening for company. Philip arranged the furniture on the balcony, and created a pleasant draft in the lounge since the residence lacked air conditioning. Despite his walker, Eugene moved about inside and outside the building as much as Philip did. In the morning or afternoon, Eugene read the newspaper and enjoyed the sunshine at the oriel window at the NSCU-2. If he was looking for a book or dictionary, he went to the glazed-in end of the other corridor, also at the NSCU-2. In the evening, Philip, Eugene and Jerome shared the habit of using the training equipment in the therapy space at the NSCU-1, but never simultaneously. Philip and Jerome often spent the evening outside the residence. Before lunch or in the afternoon, Julie preferred to sit opposite the kitchen or at the oriel window. She wanted to be close to the staff and to supervise those who entered the unit. Being a heavy smoker, Beth's dementia made her constantly search for a staff member in the kitchen area at any of the units so that they could accompany her for a smoke outside.¹⁴ The residents perceived the oriel at the NSCU-1 as belonging to the staff. The staff members used the sofa for short naps behind the folding screen. Occasionally, Augustine used the sofa for a slumber, but she also used the sofa in the therapy area at NSCU-2. Here, she acted as if the residence were a hotel lobby, attentively looking at who entered or left the unit. Accompanied by a staff member, she also took walks between the units, looking out the windows and at the rare artwork on the walls. Felix, on the other hand, was isolated in his apartment since the doorway of his apartment did not allow him the passage. On special occasions like Christmas, the staff placed him in a special wheelchair, and brought him to the lounge.

3.3 THE COMMUNAL SPACE OF THE SCUS

At the SCUs, the venetian blinds were lowered. No one on the street could catch a glimpse of life inside the building, nor could the residents contemplate exterior events. At the SCU-1, Caroline, Esther and Sophie sat at a table, where they pursued three separate monologues. After a while, Esther, carrying her purse, would leave the table to search for her purse in her apartment. She then reappeared, introduced herself and sat down. Shortly afterwards, she repeated this. Caroline used to take a nap in the sofa in the therapy area. The members of staff were busy helping the other residents, one man and five women, who remained in their apartments. Victim of a wandering and picking behavior, Thomas had appropriated the communal space and the garden for his personal usages: two places for resting, in the oriel where he piled up his findings, or in a chair outside on the terrace. Able but aphasic, he constantly rearranged the interior setting, and created invisible barriers for the others to observe. The movements in the more lit up SCU-2 were noticeable in the lounge area from the obscure SCU-1, in which the penetrating daylight from the garden created zones of light or dark. At the SCU-2, the electric lighting was turned on all the time, whereas the light at the SCU-1 was used only in the evenings. The door between the units was locked, and white drapes blinded the glass wall. The noises and the scents from the kitchen or the laundry room added to the homelike atmosphere of the SCU-2: The residents were easily agitated and depended upon the staff. One staff member said that her work required an actor's talent, since she played different characters in order to reaffirm them. One of the six residents present in the communal space, Cesar, aphasic and shrunken in his wheelchair, specially appreciated a certain staff member. They used to spend the afternoon at the oriel that became an open meeting point for any resident. Adam would approach them for a stuttering conversation during his daily inspection tour. Near the sofa in the lounge area, but in his wheelchair, Raoul preferred to sit. He supervised the staff in the kitchen, at the oriel or those who entered the unit. His dementia induced him to shout invectives out loud when someone approached, and the only way to calm him was that a staff member gently touched his arm. At nightfall, Flore in her coat became the victim of his tongue as she tried to leave the unit to "go home".

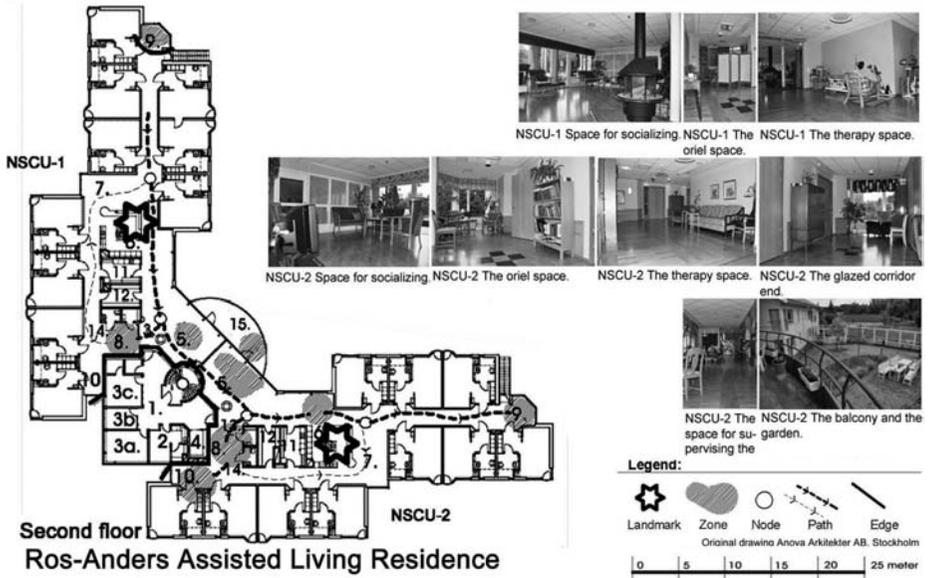


Figure 2: The spatial appropriation of elderly people suffering from somatic diseases at the NSCU-1 and

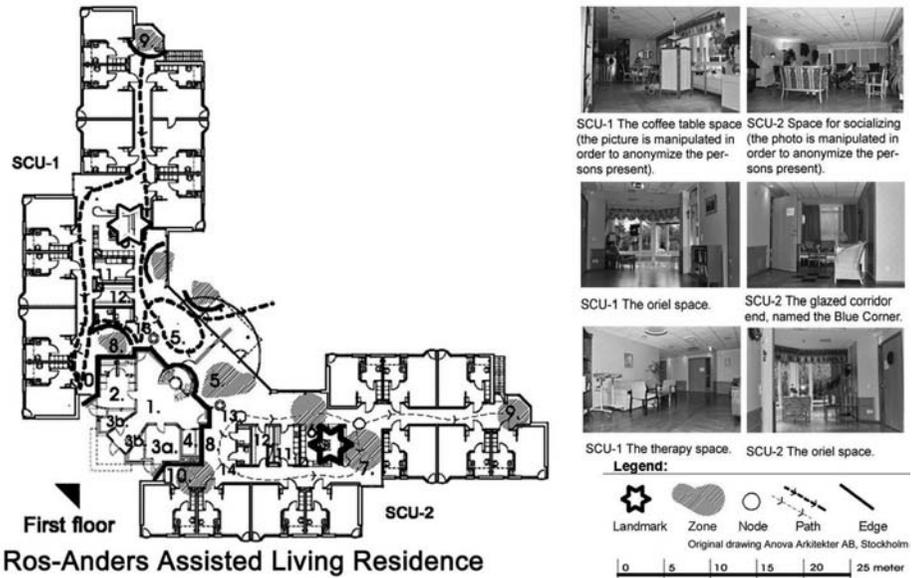


Figure 3: The spatial appropriation of elderly people with dementia at the special care units, SCU-1 and SCU-

Often, the residents became worried at this time of day, and the staff used the glazed-in end of the corridor, named “the blue corner”, to calm them and make them go to bed.

3.4 THE RESULTANT MENTAL MAPS OF THE UNITS

Three mental maps were possible to draw from the observed spatial uses, one map of the NSCUs, and two separate maps of the SCUs.

3.4.1 THE MENTAL MAP OF THE NSCUS

Based on the ten residents’ spatial appropriations, a mental map was traced over the two units (Figure 2). This map contained eight places that the residents used in different manners. It was mainly the residents’ own movements that created a network of paths that connected the places. The places were closely connected to sensuous or social stimulation, being in the sun, enjoying the view, or engaging in some sort of social activity. In line with the higher TESS-NH score, the NSCU-2 had the majority of the eight available zones that attracted the residents. At this unit, furniture arrangements created places for contemplation and socializing. The oriel window space at the NSCU-2 was used by the residents, whereas the corresponding one of the NSCU-1 was used by staff members. The glazed-in end at the NSCU-2 was equipped with an armchair and a low book-shelf containing encyclopedia and literature. At the NSCU-1, this end was used for the storing of assistive equipment. Although one unit was the inversed copy of the other, the NSCU-1 depended on the NSCU-2. The kitchens acted as landmarks, and the residents knew that they could find a staff member in this area at any time. The mental map corroborated the higher score of the NSCU-2 compared to the lower one of the NSCU-1.

3.4.2 THE MENTAL MAP OF THE SCUS

The eight residents’ spatial appropriations of the SCUs constituted two separate mental maps (Figure 3). At the SCU-1, one resident’s extensive spatial usages affected the communal space negatively for the others. This mental map demonstrated this resident’s movements all over the unit. There were only three zones, of which one was strongly appropriated by this person and connected to this person’s state of mind. The other two were used by the three other residents, but in all three cases there was a strong boundary surrounding them. On the other hand, at the SCU-2, there were five defined zones, but a weak pattern of movements. This seems to be attributable to the residents’ higher degree of dependency on the staff that created the zones at the unit. These were used to counteract the residents’ state of anguish, and they were closely interrelated with social interaction with the staff in order to affirm the residents’ self-esteem. In addition, these place exploited the sensuous qualities that the architectural space supplied by an open view onto the garden or a solitary corner for privacy. The higher TESS-NH score of the SCU-2 was attributable to this conscious use of architecture for caring purposes, whereas the lower TESS-NH score of the SCU-1 can be explained by the on-going conflicting spatial appropriation. The kitchen area of the SCU-2 had a quality of a landmark, and the residents gathered in this area to be close to the staff. This quality was less accentuated at the SCU-1, since the members of the staff were less visible in the communal space.

4. FINDINGS

Based on the observations at the four units, the elderly persons’ spatial uses were possible to translate into mental maps. The movements and sojourns created a pattern of paths and zones that interacted with the sensuous qualities of the architectural space. Given the residents’ limited capacity to move, the paths nearly disappeared at the units, where the seniors had reached a high level of dependency on the staff to be able to move around. As a consequence, few nodes were noted, especially in situations in which a choice of multiple zones to go to presented itself. The kitchen area added a landmark quality to the particular zone that evolved in its proximity. Still, the presence of staff, familiar noises, or scents seemed to be more important than architectural features. Edges between different zones depended on the distance needed to traverse in order to reach them or the invisible boundaries that the appropriating person had set up at a particular zone. The amount of available

zones at a certain unit correlated with the perceived homeliness: the higher the number of zones, the greater the feeling of a homelike environment. In addition, this correlation was traceable in a higher, but not conclusive, SCUEQS and TESS-NH scoring. These findings supply the premises on which to base five preliminary conclusions:

I) A mental map of elderly frail people's movements and sojourns in the communal space of a care unit gives an indication of the degree in which these elders perceive homeliness in the communal space;

II) A mental map demonstrates the capacity of the architectural space to add a sensuous dimension to the communal space for exploitation in everyday activities. Zones for sojourns appeared in conjunction with architectural elements that allowed for an external view, a spatial overlook and by way of these attractions generated a subsequent social interaction at this very place;

III) A mental map of the communal space indicates the degree of the elderly residents' dependency on the staff, since voluntary movements decrease in relation to aggravated age-related problems. Thus, the number of staged zones increased as an effect of the aging process and an outcome of the care work;

IV) A mental map describes an on-going place-making process initiated by the elderly frail people themselves and conditioned by their health status;

V) A mental map of the movements and the sojourns found at a unit for dependent seniors combined with the TESS-NH protocol supplies a generic environmental assessment of architectural space, interior setting and eldercare provided.

5. DISCUSSION

This paper has explored elderly frail people's inter-actions with architectural space in the context of an assisted living residence. A guiding working hypothesis has postulated that these spatial encounters resemble the ones found in an urban landscape and can be described by use of mental maps. The fundamental argument for this analogy relies on the assumption that "my body is the texture that communicates with all objects, and, concerning the understanding of the surrounding environment, my primary instrument for understanding it" (Merleau-Ponty, 1945)¹⁵. This phenomenological stance has influenced the research strategies and the aims of this study: *to explore elderly frail people's spatial appropriation of communal space through movements and sojourns, and to identify significant architectural features active in this process.*

The dependent seniors' spatial appropriation seemed to be part of an individual adjustment process to aging and the assisted living environment. This resulted in various coping strategies in which architectural space and the interior setting interacted (Küller, 1991). Apart from the mere effect of various age-related problems, a notable difference persisted between the four units, since the demented persons had not established a conscious connection with the new environment. In contrast, persons with somatic problems found zones in the communal space that suited their need for sensory stimuli, relaxation, and social contact. The necessary balance between the previous living and the new one was achieved by these intellectually lucid seniors, but not by the persons with a dementia diagnosis. Still, this equilibrium has been put forward as a key criterion for a successful adjustment to the assisted living situation (Toyama, 1988). The participants with mainly somatic diseases explained their individual motives behind a certain spatial usage, and these were aspects of a place-making process (Rosel, 2003; Rowles, 1993, 2000): The personal attachment to space and its artifacts acquired an existential dimension, and became an important *place* for this individual. In this aspect, this study corroborates previous research on place identity as a fundamental criterion for the architectural design of an assisted living residence (Brent, 1999; Peace et al., 2005; Pynoos & Regnier, 1991; Regnier, 2002; Schwarz, 1999).

This study corroborates previous research in architecture on the relation between the aging person and the ideal spatial configuration of the assisted living residence (Dehan, 1997, 2007; Regnier, 2002), and touches on the issue of architectural quality of the assisted living architecture. The architectural design of the assisted living residence in the study realized a fortunate interior spatiality, since it offered openings to the exterior space with a varying penetration of daylight and views. In addition, the interior space seamlessly incorporated different functions such as corridor, dining

room, lounge and other necessary functions in a progressively larger or smaller space (Regnier, 2002). The staff became key players in the elderly frail people's subsequent place-making process, since the interior setting had been arranged by the staff as an initiation assignment in the new work place. It is, nonetheless, noteworthy that this work seemed to have been done without any professional guidance, given the various environments created at the units. The most successful setting was found at the NSCU-2, since a book-shelf, a sofa, a side table, textiles, added meaning to the place to be, and empowered it with some sort of genius loci (Norberg-Schulz, 1980, p.170). This stronger feeling of homeliness was the probable reason for the residents of the NSCU-1 migrating to the neighboring unit. In this sense, this study adds power to the assumption that architectural space really has a therapeutic dimension (Cutler, 2007; Day et al., 2000; Devlin & Arneill, 2003; Rioux, 2003; Teresi et al., 2000), and that space is a vital parameter in the resident-staff agency (Nord, 2010).

This study has used a mixed method research design in order to explore individual usages of communal space in the context of aging and care. This approach stems from a wide consensus that states that a variety of methods increases the validity of a study (Creswell et al., 2003). The TESS-NH instrument supplied a validated protocol for a strategic environmental assessment, which was combined with observations in situ of the human interactions with the interior settings of each unit. However, the results necessitate some caution since the participatory observations might have affected the spatial usages that were identified at the four units. In addition, spatial differences between American and Swedish residences for assisted living can influence the use of the TESS-NH protocol. In a similar way, the interviewing guide might have induced the residents to present usages that were related to the interior climate that occurred during the observation period. Consequently, it has to be assumed that the spatial usages presented in this study had a momentary character and were changing over time. However, the definition of mental maps based on the Lynchian pentad makes this study explorative (Bodin Danielsson, 2005; Lynch, 1960), since few other studies with a similar methodological approach have been identified during the preparation of this study. All the same, since 45 per cent of the residents participated in the study, and multiple sources of knowledge were used to triangulate data (Yin, 2003), the conclusions are credible and transferable to similar situations involving architectural space and aging (Maxwell, 1996).

CONCLUSION

By a post-occupancy and mental mapping approach, this study has focused on end-users values in architecture for an assisted living residence and other interior incitements to promote dependent seniors' spatial appropriation. The results suggest that the elderly persons' usages of space, conditioned by the aging process, can be promoted by the architectural design and interior measures that enhance this design. The overarching conclusion of this study is that the perceived homeliness of an assisted living setting is the result of a place-making process that can be described by mental maps. Besides general requirements of accessibility, functionality, and usability, the higher the number of places in the communal space, the greater the degree of perceived homeliness.

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ENDNOTES

1. These quotations are taken from the French novelist and play-writer Honoré de Balzac (1799-1850), and the novel *Le Père Goriot*, (Balzac, 1835): "Like other passers-by, the most light-hearted becomes saddened at this site, where the sound of a vehicle becomes an event, the building is gloomy, and the walls smell like prison"

(page 5, translation by author). The third fragment is taken from Balzac's foreword to his magnum opus *La Comédie Humaine*, (Balzac, 1842) where he explains his ambition to present a panorama of contemporary French social life: "Thus, the work to be executed must have a threefold shape: the men, the women and the things, i.e. the individuals and the materialistic concretisations of ideas and beliefs, which they understand" (page 9, translation by author). The word *architectonographie* is a French word that has not yet entered the English or the Swedish encyclopaedias. According to a French-English dictionary of 1897 it is an extensive description of architecture (Wilson, Joseph, 1897: Harvard College). Originally, "architectonography is the science to describe buildings, and the art to establish with precision and exactitude the state of any type of constructions or buildings, like the house, the garden, the monument, the manufactory, the factory, etc," (Maxwell, 1996; Mimouni, 1999, p. 83, translation by author). The phenomenon is often found in the realistic tide of the European literature of the early 19th century. The use of the quotations stemmed from an idea to lighten an inventory of twelve exemplary assisted living residences in the Swedish magazine of Architecture that the author wrote in 2004 (Andersson, 2004).

2. This paper uses the term assisted living to describe the Swedish type of sheltered housing although this term is complicated due to the different regulatory status found in the European countries and the US (Andrews, 2005). In this paper, the term assisted living is seen as a type of residential home. Swedish facilities for assisted living imply an individual apartment of approximately 20-40 square-metres offered by the municipality after an assessment of the individual need of assistance and eldercare. The dependent senior receives a lease of an apartment. In addition to the monthly rent, the tenant pays a fee proportional to the assessed need of eldercare. Spatially, the apartment is optimized, and this type of housing together with housing for university students holds a special section in the Swedish Building Act. Additional space for kitchen, dining and socializing is found in communally shared premises in order to meet the national guideline of an appropriate private habitat (NBHBP, 2008). Besides this communal space, additional space is required to provide an appropriate working environment. The assistance and eldercare work is provided either by the municipal eldercare or by private entrepreneurs in this field of services. Regularly, the Swedish municipalities propose commissions of assistance and eldercare, which are a time limited contract open for renegotiation in case of ill provided eldercare or malpractice.

3. In 2005, the assisted living was converted into housing that solely welcomes elderly frail people suffering from dementia. Existing residents with primarily somatic problems were offered to move to other facilities in the municipality, and the majority chose to do so. Still, two informants with somatic problems chose to remain at the residence.

4. A third floor contains staff space, namely change rooms, a rest room, and space for meetings and preparing lunch or coffee.

5. Originally, the meals were prepared and cooked in the unit kitchen. Depending on the elderly residents' increasing need of assistance, this was changed in the beginning of the new millennium. Instead, meals are prepared at one centrally located catering service in the municipality of Haninge. Using canteens, the food is transported to the assisted living residence, and reheated in the kitchen before serving.

6. At Swedish assisted living residences, the medical diagnoses are classified information. The characteristics of each elderly person are based upon the information that the individual provided herself or himself, or what the staff members reported. The medical conditions used in this paper are a layman's assessment based on information provided and correlated with characteristics of the Alzheimer's disease (Blennow, Leon, & Zetterberg, 2006; Kolb & Whishaw, 2002). The fictitious names are taken from balzacian novels, (Balzac, 1842).

7. Questions number 6a-b, 15, and 16a-i were excluded, since they did not supply computable facts.

8. The exception is question 29 that was assigned the highest score, nine points, since all residents had an individual apartment, and shared rooms do not exist in Swedish assisted living residences, other than for couples in a larger apartment.

9. The documentation served as a means to analyze discrepancies between the American recommendations for nursing homes and the Swedish architectural guidelines of assisted livings. The photographic documentation of each unit was performed without flash, and without the presence of any resident or staff member within the picture frame. A plain glass lens was used on a photographic zoom lens of 1:35-45 28-80 mm, and a 400 ISO color film (Fuji color).

10. This section in was inspired by the French Photolanguage method (Baptiste, Belisle, & Pechenart, 1991).

11. On some occasions, the author took coffee with the residents and the staff, although it had been agreed that meal times should be respected and excluded from the observations, since the majority of the residents were in need of assistance and the staff heavily occupied in helping them.

12. The author of this paper was invited as a presenter at the three-day seminar of Vadstena Forum, 1st-3rd June in 2005. This seminar constituted a meeting between municipal and regional decision-makers and researchers representing on-going research on the interaction between aging, architecture and eldercare. The theme for the seminar was the "The reverted population pyramid". The preliminary report with seven fictitious characters and their use of the interior setting was prepared for this occasion and published in the proceeding report of the conference (Andersson, 2005a).

13. In this context, another parameter comes of importance: At the Swedish technical universities funding is correlated with the two-step procedure of a doctoral thesis. Consequently, new funding is required in order to proceed from the licentiate thesis and continue with the doctoral thesis. In this particular case, the research project had to remain dormant during the period 2005 to 2007.
14. In Sweden smoking is only allowed outside of the building.
15. "Mon corps est la texture commune de tous les objets et il est, au moins à l'égard du monde perçu, l'instrument général de ma « compréhension »." (Merleau-Ponty, 1945, p. 272, translation by the author).

Creating regional Detroit's first "net zero energy" community

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ABSTRACT:

A multi-disciplinary faculty/student research team (the Team) at an accredited Architectural School, is partnering with the Southwest Detroit Development Collaborative (SDDC) to create a plan for our region's first "net zero energy" community by defining and modeling key elements of a sustainable community to inform the future urban form of Southwest Detroit.

Guided by our investigations, we will make recommendations on how existing community initiatives and the SDDC can use energy solutions, density, and community empowerment to create a sustainable community. The team is focusing on three areas: ecological footprint, LEED ND, and hybrid alternative energy.

Utilizing our unique digital mapping interface, we will add relevant data, model "analysis layerings", and make specific design proposals for these key elements: energy hubs, green economy, targeted, mixed-use density, and green infrastructure to support enhanced pedestrian mobility, mass transit, and electrical vehicle fleets. This project is consistent with the U.S. Green Building Council's Leadership for Energy and Environmental Design [LEED and LEED ND] and will integrate LEED criteria into our digital mapping interface to recommend where points can be gained for sustainable design.

The team will incorporate alternative energy sources such as solar and wind power systems which are the foundation of powering residential, commercial and industrial needs, recharge stations for electric vehicles, sub-grade battery banks, and a system for compressing air in unused salt mines underneath Southwest Detroit. We will establish an ecological footprint for the community, identifying opportunities for repurposing of vacant land and development of alternative energy to drive and support sustainable community and economic growth. It is hoped that the outcome of this research would make Southwest Detroit our region's first net zero energy community, serving as a prototype for the rest of the city and state, as well as cities worldwide.

CONFERENCE THEME: Sustainable Paradigm: Creating Detroit's first net zero energy community

KEYWORDS: sustainable urbanism, urban mobility, alternative energy, densification, digital mapping interface

INTRODUCTION

INTRODUCTION AND PROJECT SUMMARY

A multi-disciplinary faculty/student team (The Team) is building on an existing collaboration with the Southwest Detroit community through the Southwest Detroit Development Collaborative (SDDC) and with the generous support of the Ford Motor Company's College Community Challenge (Ford C3)¹. The Team is partnering with four established SDDC committees: Transportation, Housing, Green Infrastructure and Economic Development and WARM Training to create a plan for Regional Detroit's first net zero energy community. The Team is investigating the roles that an innovative hybrid alternative energy solution, density, and community empowerment play in creating a sustainable community. Further enhancing our unique GeoDesign digital mapping interface on a Google Earth Platform and incorporating geographic information systems (GIS), the Team will add relevant data for vacant parcels and infrastructure, model "analysis" layerings and make specific urban design proposals for the key elements of a sustainable community: alternative energy, mixed use density, urban mobility, public realm and green economy to support enhanced urban mobility, including improved pedestrian environments, mass transit and electrical vehicle fleets (EVs).

CONTEXT

SITE CONTEXT

Detroit, MI, USA, currently the 11th largest city in the US, is located at the center of the Great Lakes Basin bioregion. Detroit's challenges have been well documented in the national and international media.² To address vacancy disinvestment and other structural issues, the current Mayor has recently initiated a "right-sizing" plan for the city, entitled the Detroit Works Project³. Despite the prevailing perception, Detroit still has viable, even thriving, neighborhoods. The project context, Southwest Detroit is a diverse and vibrant community, and serves as an ideal prototype for building a sustainable community. The 12,450 acre (19.45 square mile) neighborhood is bordered by the CBD to the east, the Detroit River to the south and the Rouge River to the west. See *Figure 1*.



Figure 1: Diagram Detroit Municipal boundary and Southwest Detroit [Inset] (Studio [Ci], 2010)

The neighborhood contains the junction of major highway and rail infrastructure, and serves as a critical regional transportation hub which can be leveraged for the creation of the Team's recommended alternative hybrid energy solution. The neighborhood has a base of high wage jobs and established employers within and adjacent to its boundaries (Ford Rouge Plant, Severstal Steel, National Steel, The Port of Detroit, etc.). This history of stable economic activity can be leveraged to establish and grow a future green economy. This industrial legacy has also supplied brownfields and vacant buildings and parcels that become adaptive reuse opportunities for establishing sustainable targeted mixed use density. Southwest Detroit is socially sustainable due to its diverse demographic profile, and is one of the only neighborhoods in Detroit that is adding population.

The authors considered other neighborhoods and organizations to partner with for the Ford grant; however, Southwest Detroit proved the ideal choice. It allowed the Team to build on past collaboration with a community partner and to expand the scope of work to meet the primary author's pedagogic and design research objectives of focusing on the role of density in sustainable urbanism. It also allowed the Team to meet funder goals in several ways. The project gives Ford the opportunity to produce a prototype sustainable community in the shadow of the historic Rouge Plant, which William McDonough+Partners, Dirt Studio, et al created a sustainability Master Plan which includes the construction of new plants, alternative energy, and landscape interventions.⁴ Further, it allows Ford a chance to leverage other investments in Southwest and Detroit proper.

2.0 APPROACH AND RESEARCH METHODOLOGIES

The Team believes that as designers, we must look *beyond the building* employing a holistic approach to the city and its urbanized region. The Team's research subscribes to current theoretical and design approaches to systemic design⁵ and sustainable urbanism⁶. We believe there are valuable lessons to be

learned by focusing on post industrial cities, rather than cities in BRIC nations that are experiencing explosive growth. No matter its growth profile, the city is a consumptive entity, challenging its ecological context. As Mostafavi observes:

How can the city, with all its mechanisms of consumption – its devouring of energy, its insatiable demand for food – ever be ecological? In one sense the “project of urbanism”...runs counter to that of ecology, with its emphasis on the interrelationship of organisms and the environment – an emphasis that invariable excludes human intervention.⁷

The Team is expanding upon the established methodologies for *carrying capacity*⁸ to define a *tipping point* of human habitation in the urban context; defined as: a level at which the new eco-system created through built and population densities begins to negatively impact the natural environment and ecology of an urbanized region. For civilization to endure, cities must begin incorporate into the natural systems that support their existence⁹. In support of this systemic approach we define urban infrastructure broadly as blue, green, gray and white, and view it as the eco-system of the sustainable city, both reinforcing and defying social, political, and cultural boundaries in the same manner as natural systems. We believe that any design and/or policy recommendations that inform the city must simultaneously seek to understand, document and artfully integrate social, economic and environmental parameters. We utilize our research methodology to support the creation of both formal and policy recommendations to encourage informed decision making around balancing the long term benefits and impacts of urban density.

For the Ford C3 project, we have defined the elements of a sustainable community, including social, environmental, and economic aspects, see *Figure 2*.

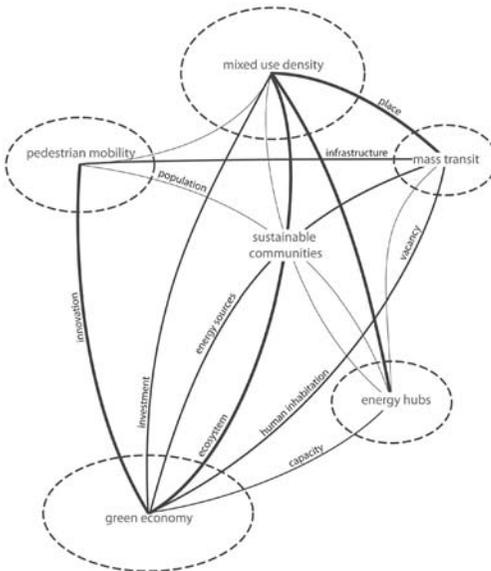


Figure 2: Strategy for a net zero energy community (Studio [Ci], 2010)

The Team is employing a collaborative and inter-disciplinary approach to the project. The Team works with the community through visioning, goals establishment, and the generation of deliverables to create a plan for a *net zero energy community*. This methodology borrows from established participatory planning processes in support of sustainability¹⁰. We are cooperating with our community partner on three tasks: community process+technical assistance, data input+analysis, and design+policy recommendations. Each task features community engagement, training, and specific deliverables to ensure that the project can endure after the Ford C3 grant is complete. *Figure 3*

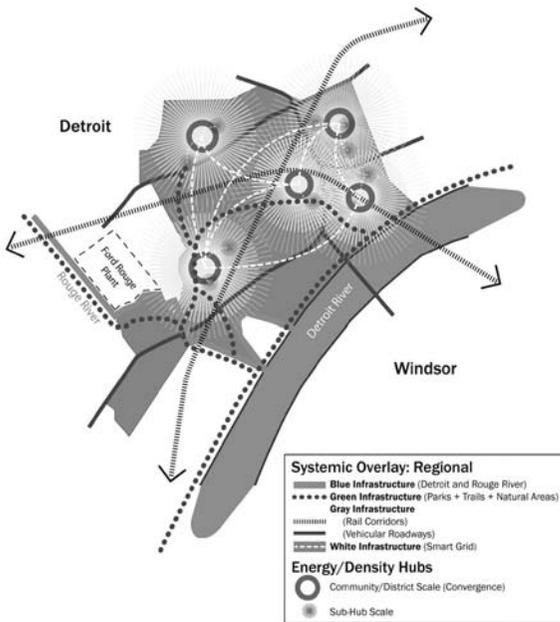


Figure 3: Holistic and Systemic Approach to Creating a Net Zero Energy Community. (Studio[Ci], 2011)

2.1 THE CONVERGENCE OF INTENSITY [CI] METHODOLOGY

The fundamental question in building a sustainable community is: where and how will we sustainably redevelop and support resident populations with energy, infrastructure, services and investment? Since answers to this essential question in Detroit have been dominated by capricious political, market, and social forces, the authors believe that application of metrics and a “criteria driven” approach and are essential. Further, that a new urban geography and eco-system are required which leverage the assets and complex combinations of forces of the city-scape. Through the Ford C3 project, we hope to continue to empower the community and prompt a civic dialogue around building a sustainable community. The SDDC and member Community Development Organizations (CDOs) are already creating a culture of sustainability in Southwest Detroit, and this project is assisting in engendering this culture throughout the entire community. Our ongoing efforts in Southwest Detroit have focused on the role of density in sustainable communities.

The authors believe that sustainable community begins with *Value Densification*: an urban design theory, a community process, and a digital mapping interface to empower the community and prompt a civic dialogue toward:

“...a focus on investment and development in neighborhoods and districts where inhabitation, infrastructure, cultural and employment assets [and value] are in evidence.”¹¹

The authors are interested in relevance and the applicability of the digital interface. The response is: Convergence of Intensity [Ci]:

“a value based approach which builds on Value Densification and recommends the new geography of the city. Ci proposes specific criteria for building sustainable communities, arguing that balanced, sustainable, dense and urban development is still possible in a post-industrial city like Detroit. The methodology empowers communities to proactively identify and design for the coming together of a broad host of metrics into a spatial convergence. The primary author defines this purposeful phenomenon of re-sizing the city based upon these metrics as a convergence of densities [intensity] intensive convergence or a convergence of intensity [Ci]”¹².



Figure 4: Screenshot of Data Layers in our digital mapping interface using Google Earth. (Studio[Ci], 2009)

Our methodology empowers cities to proactively identify and design for the “coming together” of population, energy, capacity, investment, blue, green, gray + white infrastructure and existing built form into a spatial convergence. We define this purposeful phenomenon of re-vitalizing the city based upon broadly defined density metrics as a convergence of intensity [Ci]. Our Ci methodology consists of three steps:

2.1 IDENTIFY AND MAP BROADLY DEFINED DENSITY METRICS/ASSETS

First, we identify and map density metrics/assets. As urbanists, we believe that density/intensity is sustainable and should be broadly defined and visualized in three primary categories:

1. *Human [inhabitation]* – Focusing on stable, even growing populations. Concentrations of inhabitation serve as the primary criteria. For the Ford project, we are mapping data sets on immigration, age and ethnicity.
2. *Cultural [place]* – Focusing on layers of built and narrative heritage. Concentrations of such resources and embedded meaning become the second criteria. For the Ford project, we are mapping data sets on vacant land and housing¹³, among others.
3. *Infrastructure [ecosystem]* – Focusing on the rich investment in physical and technological infrastructure that supports manufacturing and movement of goods and services and the human settlement associated with these activities. For the Ford project, we are mapping blue, gray, green, and white infrastructure.

We obtain primarily publicly available data from a variety of sources (US Census, etc.) to create “data layers” in our interface. We then create three-dimensional extrusions of the data, so the community can easily see and interpret concentrations of intensity. To date, we have mapped over 115 layers for Southwest Detroit. (See Figure 4)

2.2 CREATE ANALYSIS LAYERINGS UTILIZING DATA LAYERS TO INFORM FUTURE POLICY, PLANNING AND DESIGN:

Second, we create “Analysis Layerings” [or mash-ups] utilizing data layers to inform future policy, planning and design. The Team’s methodology and digital interface allow for multiple data layers to

be overlaid simultaneously so one can see the “convergence of intensity” of community resources/assets. This can construct infinite combinations for collective dialogue, decision making, design recommendations and implementation. The SDDC’s Transportation Committee is focused on several large scale infrastructure projects: the Detroit River International Crossing, and Detroit Intermodal Freight Terminal, among others. An example of how the digital interface supports advocacy efforts is illustrated in the Transit Analysis Layering in Figure 5, which is comprised of three data layers. Armed with the information, the community is utilizing this layering to advocate with their elected officials for a much needed transit stop in their neighborhood.

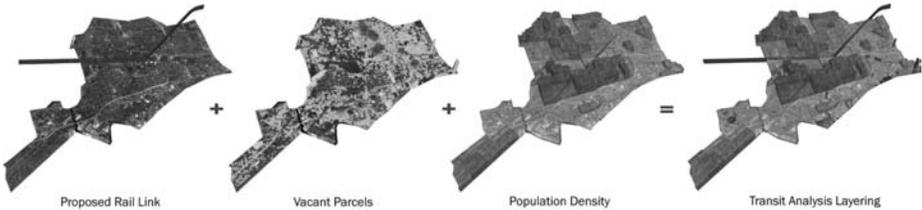


Figure 5: Screenshot of “Transit Analysis Layerings” (Studio[Ci], 2009)

2.3 DETERMINE THE “GEOGRAPHY OF CONVERGENCE” TO DEVELOP FORMAL DESIGN RECOMMENDATIONS

Our third step is Design. In the first application of our methodology, we began by determining the “Geography of Convergence” -- mapping concentrations of assets based on five [5] metrics [criteria]: energy (organizations and informal cultural assets), capacity (as of right zoning), population (density by block group), investment (business and employment density by block group), and infrastructure (neighborhood parks, greenways, proposed rail link) to develop formal design recommendations. Figure 6.

The resultant analysis layering shows the new “geography of convergence” within a ¼ mile walking radius of social, economic and environmental asset density in the Southwest Detroit neighborhood.

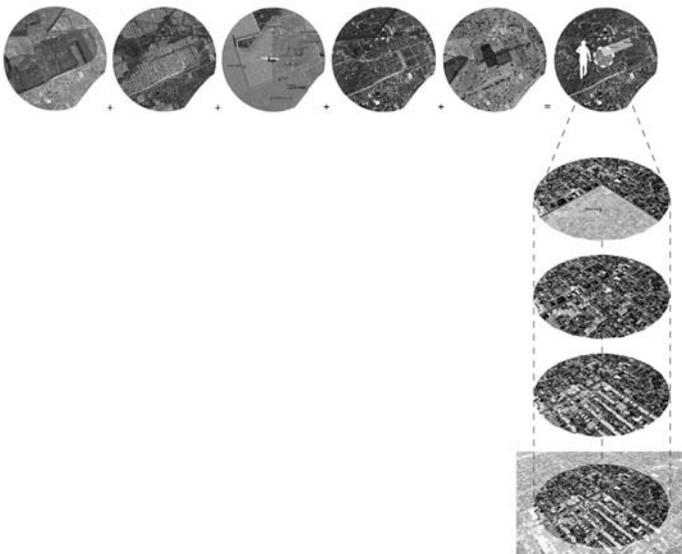


Figure 6: “Geography of Convergence” (Studio[Ci], 2009)

2.4 DESIGN APPLICATION

In this district-scale design application, we partnered with the Southwest Detroit community in 2009. The community client selected Scotten Park a 53 acre area of Southwest Detroit, as a “beta test”. Michigan State Housing Development Authority [or MSHDA] subsidies had been granted to build housing in the district. First, we conducted site visits and existing conditions documentation. Next, we generated a digital model of existing built and proposed development for the study area. Figure 7 (top left) illustrates the community client’s, MSHDA application illustrating low density (8-3BR) townhouses on the identified development parcels. We then we identified all vacant parcels in the study area that were “buildable” and realistic for future development. Our proposal yielded an additional 30 development parcels.

We developed an urban design rationale, utilizing GeoDesign tools and principles to guide our density recommendations, including:

1. *As of Right Zoning* – the study area contains two zoning districts: R2 + B4. Each allows a maximum height of 35’, with front and side setbacks from parcel lines based on existing built context.
2. *Street Grid* – the perimeter streets are four travel lanes each with widths that allow for more height and density, and also present the opportunity to continue the existing pattern of ground floor commercial.
3. *Solar Orientation* – the study area is ideally oriented with southern exposure. The proposed building massing reflects opportunities to maximize sunlight future green infrastructure.
4. *Circulation + Public Realm* –proposed buildings are massed and sited to concentrate pedestrian traffic and entry along perimeter and residential street frontage and contain residential vehicular traffic and parking access via existing alleys. Initial opportunities for green courtyards between and alongside residential buildings were identified.
5. *Building Typology and Program* – two new typologies were recommended: Mixed Use [with Ground Floor, Commercial] and Apartment Residential. We modeled the maximum density allowed under the current City Zoning ordinance. Our “MAX Zoning proposal” is 55 units/acre and 6.5 times more dense “as of right” than the client’s MSHDA application! We designed and modeled 30 new mixed use residential buildings with 482,458 sf. of proposed residential density distributed among 488 total units [111 one bedroom units; 236 two bedroom units; and 141 three bedroom units] and 62,108 sf. of new commercial density in the study area. This proposed density, if built, would essentially double the real estate portfolio within walking distance of the convergence of densities found in the “Analysis Layering”. *Figure 7.*



Figure 7: Design Application: “MAX Zoning proposal” utilizing our digital mapping interface (Studio[Ci], 2009)

We have been encouraged by the results of our initial design process and the resultant formal recommendations and are motivated to continue to enhance the Ci design methodology and interface. We are in the process of implementing a Sketch-Up plug-in software called *Modelur*¹⁴ that creates parametrically controlled building forms for urban scale study.

2.5 APPLICATION OF THE CI METHODOLOGY FOR FORD C3

The project involves employing our digital interface and applying the Ci methodology to meet the goals of the project. This includes mapping context layers of regional energy and new layers, such as Detroit's underground Salt Mines, and updating existing layers, such as vacant parcel layers, and blue, green, gray, and white infrastructure layers, etc. In the initial phase, the Team mapped the proposed major green community projects of interest to the SDDC committees along with the potential impact areas within the community.

The Team then created analysis layerings to determine the new geography of a sustainable Southwest Detroit. This allows us to define the location of concentrations of where to densify, where to site energy hubs, etc. Based on this new geography, we are locating, designing and modeling urban design recommendations for the five key elements: energy hubs, green economy zones, concentrations of targeted, new mixed use density and green infrastructure to support enhanced pedestrian mobility, mass transit and EVs. These urban design recommendations will serve as the core of the Plan. Eventually we will evaluate impacts and benefits of the plan by remodeling the Eco-Footprint for the neighborhood.

3.0 REPRESENTING AN INNOVATIVE APPROACH TO "BUILDING SUSTAINABLE COMMUNITIES"

The Team established a team research methodology, documentation standard and RefWorks account for seven categories to support our process: Eco-Footprint, Alternative Energy, Software, Urban Mobility, Implementation, Regulations+Incentives and Local+Regional+Global Precedents.

In researching precedents for the design of 'net zero energy' communities, we looked both globally and within the Great Lakes Basin in order to learn from and model relevant climatic, cultural and economic conditions. We have researched Masdar City¹⁵ outside of Abu Dhabi designed by Foster Partners, and find that there is relevance to our work in Southwest Detroit, particularly in regard to the goals and principles established for the project, including: Synergy, mobility, energy, and quality of life. Further, the design of Masdar City was guided by 10 principles of *One Planet Living*¹⁶.

However, we find the relevance of Masdar City, and similar precedents, limited, because the project is new construction located in the middle of a desert with significantly different climatic and capacity conditions to Detroit. More relevant precedents relate to extant urban areas with similar climatic and capacity conditions, such as the town of Vauban outside of Freiburg, Germany, the recent work of NYIT Professor Tobias Holler for Long Island, New York, and MIT Professors Andrew Scott and Eran Ben-Joseph for the Tama New Town, close to Tokyo¹⁷.

We have defined and modeled key elements of a sustainable community to inform the future urban form of Southwest Detroit. The Team employs a value/asset-based, community-driven approach for the identification of resources. The Team's unique GeoDesign digital mapping interface on a Google Earth Platform and incorporating geographic information systems (GIS), allows for diverse data and software inputs.

3.1 ECOLOGICAL FOOTPRINT

The Team began the project with the objective of establishing an ecological footprint for Southwest Detroit. This Eco-Footprint is intended to provide a baseline for evaluation of existing capacities, demands and impacts for attainment of a 'net zero' energy profile through specific outcomes (e.g., the urban design and policy recommendations). There exist two generally accepted methodologies to create an ecological footprint: the Compound Method¹⁸ developed to measure the ecological

footprint of nations; and the Component Method to measure the ecological footprint of cities¹⁹.

We conducted a literature search of current methodological approaches, with particular emphasis on the work of William Rees and Mathis Wackernagel, the Global Footprint Network, et al²⁰. An ecological footprint is defined as,

“A measure of how much biologically productive land and water an individual, population or activity requires to produce all the resources it consumes and to absorb the waste it generates using prevailing technology and resource management practices. The Ecological Footprint is usually measured in global hectares. Because trade is global, an individual or country’s Footprint includes land or sea from all over the world.”²¹

However, these methods, while applicable to an individual, a city or a nation, proved limited for our purposes to establish a baseline Eco-Footprint for the mid-scale: an urban neighborhood. We devised an alternate methodology based on these proven methodologies, to support the sustainable design goals of the project.

We first structured our Eco-Footprint with three main categories: capacities, consumption and impacts. We defined six subcategories of consumption: 1_land+built form, 2_water, 3_food, 4_energy, 5_mobility, and 6_materials+goods+services. Our defined capacities include: land capacities, build out envelope, aquifer/watersheds, microclimate+renewable energy sources, infrastructure, housing, retail and living wage jobs. Figure 3 is a detailed graphic depiction of the complex interrelationships of our mid-scale eco-footprint.

Our second step was to establish two consistent metrics which will generate all other supporting statistics. First, is the population of Southwest Detroit at 106,749 (2010 Census) and second, the area of Southwest at 12,450 acres. We decided not to convert to a standard unit of measure, (e.g., adapt all metrics to standardized global hectares), but allow metrics to vary within the six categories. However, we will maintain these metrics consistently across from capacity to impact. All metrics are based on current and/or actual data; extrapolated or interpolated²².

Our third step was to research publicly accessible databases²³ establishing metrics for each subcategory of consumption, (e.g. for 4_Energy, BTUs by sector and energy sources. Impacts were defined by the six demand subcategories, and include primarily waste flows, but also percentage of land required to absorb or sequester waste, and other impacts. Impacts are primarily a result of consumption and will be further quantified and qualified in the design phase of the work. *Figure 8.*

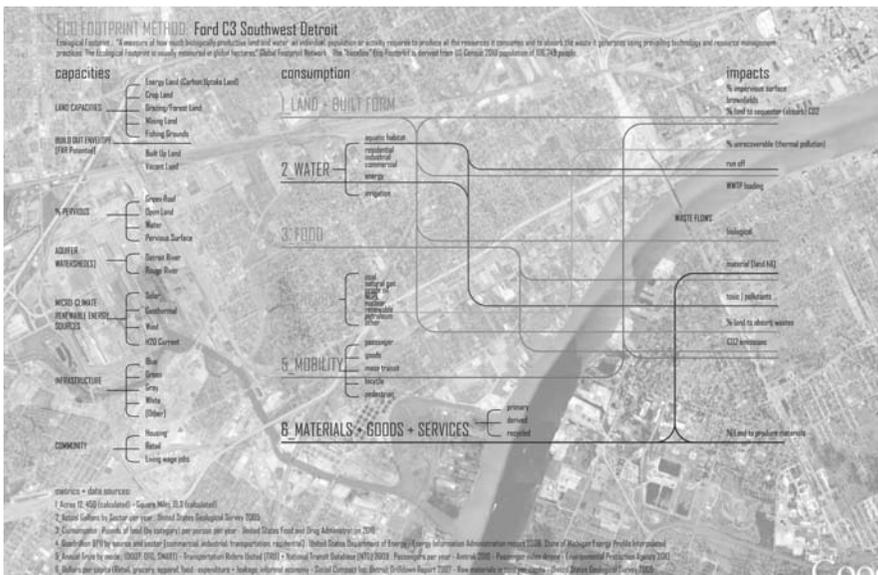


Figure 8: Diagram for Eco-Footprint Method: Southwest Detroit (Studio[C], 2010)

The fourth step was to create an accompanying Excel spreadsheet to document and calculate supporting data sets for each Eco-Footprint category. For example, in the 4_Energy subcategory, we hoped to find local usage data from Detroit's local energy provider, Detroit Thermal Energy [DTE], but instead used the Department of Energy's [DOE] Energy Information Administration [EIA] Annual Energy Review²⁴ representing long-term historical statistics for all source categories. EIA data includes State level data by energy source and sector, which we interpolated using 2010 Census population figures for the neighborhood. Ultimately, we plan to utilize our digital interface to map aspects of the neighborhood's Eco-Footprint, and then evaluate with real time dynamic assessment the positive and negative impacts generated by our urban design proposals.

3.2 APPLICATION OF US GREEN BUILDING COUNCIL LEED NEIGHBORHOOD DEVELOPMENT RATING SYSTEM

The community partner is enthusiastic about exploring how our unique digital mapping interface can be utilized in order to plan for a changed environment. This work is consistent with the focus the USGBC has on *regionalization*, as we will identify bonus point opportunities for sustainable design through LEED-ND (Neighborhood Development). Our approach includes an integration of LEED criteria into the digital mapping interface and recommends that points can be gained based on strategic location, energy, mixed density, and green infrastructure to enhance pedestrian mobility and mass transit. This will align with the SDDC's current model of community investment strategy, which not only focuses on criteria, but also on methods to affect a positive impact within the community.

This approach consists of developing sustainability metrics, both in terms of identifying sustainable development opportunities, as well as subsequently prioritizing areas not suitable for neighborhood development, but alternatively prioritized for open space/recreation, energy hubs, or other non-residential purposes. The LEED-ND²⁵ rating system was selected due to its quantitative rating system that we will use in the prioritization of sustainable neighborhood developments. LEED-ND is a rating system developed jointly by the US Green Building Council (USGBC), Congress for New Urbanism, and the National Resource Defense Council, and it focuses on:

...the design and construction elements that bring buildings together into a neighborhood, and relate the neighborhood to its larger region and landscape (USGBC, 2007).

The metrics that define sustainability in this system include transit-oriented development (TOD), sense of place, mixed-use density, infill development, conservation of wetlands & agriculture, reduction on the dependency on individual automobile transportation, energy efficiency, and walkability, among others. The rating system has three categories of credits (requiring prerequisites in each category), and two categories for bonus credits. The three core categories are: *Smart Location and Linkage (SLL)* – neighborhoods that minimize adverse environmental impacts and avoid urban sprawl, *Neighborhood Pattern and Design (NPD)* – compact, mixed-use neighborhoods with connections to surrounding communities, *Green Infrastructure and Buildings (GIB)* – reducing the environmental impacts of buildings and infrastructure. The two bonus categories are: *Innovation and Design Process (IDP)* – exceptional performance above the requirements or innovative performance not addressed by the rating system. *Regional Priority Credits (RP)* – projects located within areas identified by USGBC as being “regionally important.”

A GIS model will be developed identifying spatially based prerequisites within each of the above categories to ensure the neighborhoods are eligible to pursue LEED-ND certification. GIS will be used for its potential to quantify spatial relationships, which are often used in the LEED-ND system to identify credits and prerequisites. For example, the second prerequisite in the NPD category requires the proposed development must have 140 street intersections per square mile, or an average of 90 intersections per square mile in the adjacent land around the development within ½ mile. (Figure 9) This calculation will be done across the entire Southwest Detroit boundary to determine intersection density, thus identifying where the LEED-ND system is eligible. Similar calculations will be conducted on all prerequisites and thus, prioritizing the sustainable communities within Southwest Detroit.



Figure 9: Neighborhood Intersections (Studio[Ci], 2011)

Many of the parameters in LEED-ND require comparative analysis of the broader region to meet certain prerequisite criteria, and sustainable development credits. Using Southwest Detroit as our project boundary, we will compare the neighborhood to the average values of Wayne County, Michigan as the broader region for the comparative analysis. Data sources include US Census, Social Compact, American Community Survey, Southeast Michigan Council of Governments (SEMCOG), and other publically available data.

The areas that have been identified to meet all prerequisites in the LEED-ND system will be compared with locations identified by our community partners where sustainable developments are currently being pursued, and other “Analysis Layerings” generated through the Ci methodology. This will focus the dialog between community members to ensure that the specific resources of each community are used to the fullest potential. Figure 10.



Figure 10: Neighborhood Pattern and Design (NPD) - An intersection count was conducted within a 1/2 mile radius of Michigan Central Station in Southwest Detroit. The results revealed a total of 165 intersections, surpassing the minimum requirement of 140. (Studio[Ci], 2011)

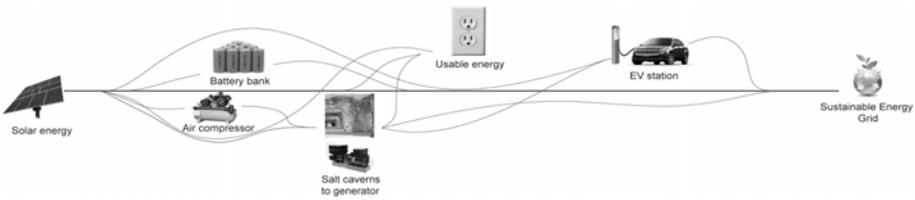


Figure 11: Proposed Hybrid Alternative Energy Approach. (Studio[Ci], 2011)

3.3 THE HYBRID ALTERNATIVE ENERGY APPROACH

The Team and the Southwest Detroit Development Collaborative (SDDC) are interested in implementing alternative energy through several different approaches, including solar, geothermal, and hydro current, to generate energy during different seasons throughout the year. The Team features designers as well as engineers, and believes that a hybrid approach is far more effective than a singular alternative source. As the SDDC works with the city of Detroit on the demolition of 10,000 vacant homes in their targeted service area, the Team has identified the opportunities for the repurposing of vacant land to locate alternative energy collection hubs.

Another approach that will be investigated to supplement the energy system is the storage in the form of sub-grade battery banks. All of these approaches to hybrid alternative energy can and should be integrated into the neighborhood not only for residential, commercial and industrial needs but for sources for EV charging stations and mass transit furthering the goal of carbon neutrality. *Figure 11.*

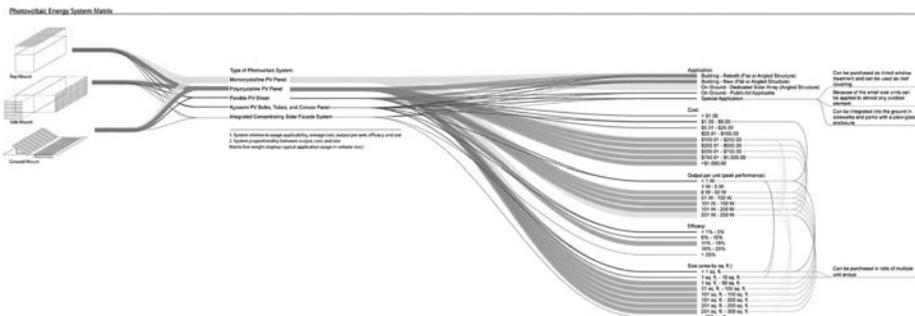


Figure 12: Diagram describing the costs, application and efficiency of solar panels by type. (Studio[Ci], 2011)

An important portion of energy usage for any community is in building heating and cooling, which impacts residential, commercial, municipal, and to a lesser extent industrial energy consumption. To help understand these energy demands for Southwest Detroit one can use the quantitative measure of heating degree days²⁶ and cooling degree days. Data are compiled for a three year period from 2008 to 2010 in *Figure 13* below, and shows high heating demand in the late fall through spring months and high cooling demand in the summer months.²⁷ In the Detroit area fossil fuels provide heating, and electricity provides cooling for air conditioners. Alternative energy systems need to address heating and electrical needs.

Alternative energy resources most suited to this area are solar, geothermal heat pumps, submerged river turbines, and subterranean compressed air. Wind energy is not applicable here due to poor wind availability throughout the year. The annual wind classifications of class 1 (poor) or class 2 (marginal) ratings show that wind is not a viable option, unless turbines are elevated at least 100' above grade.²⁶

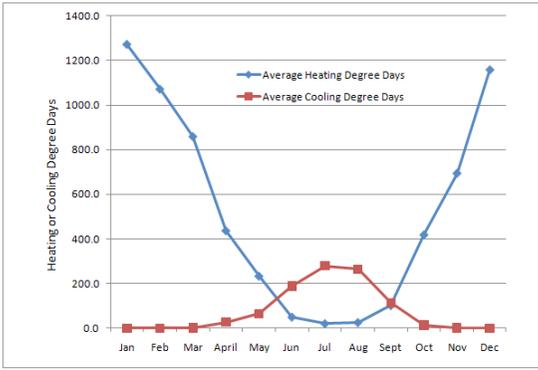


Figure 13: Average heating degree days and cooling degree days for Detroit from the years 2008 to 2010. (Studio[Ci], 2011)

Figure 14 below illustrates the available solar energy for a flat panel at a 27° angle (latitude minus 15 degrees, or 42° – 15° = 27°) in kWh per m² for the Detroit area for each month.²⁸ Correcting for the optimal panel angle of approximately 30° at this latitude on annualized basis yields 1912.9 kWh/m²/yr. Southwest Detroit comprises 12,450 acres (5.038 x 10⁷ m²) and yields 7.837 x 10¹⁰ kWh of solar energy. If 30% of this land could be utilized for solar photovoltaic systems, accounting for the tilt angle and shading from the tilted panel’s footprint, and also accounting for 15% and 95% efficiencies of the photovoltaic panels and inverters respectively, then approximately 2.300 x 10⁹ kWh of solar energy is available annually.

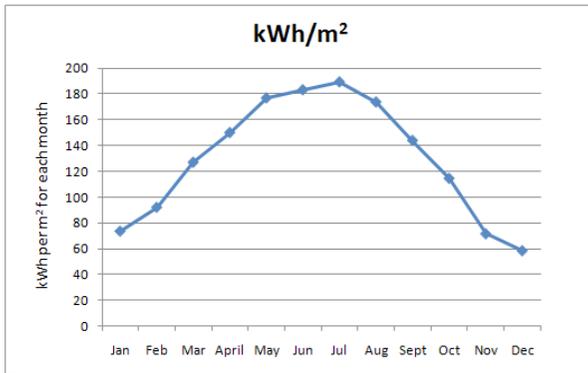


Figure 14: Monthly solar energy available to Southwest Detroit in kWh per m². (Studio[Ci], 2011)

Geothermal heat pump energy availability data for Southwest Detroit is based on known systems in the region and their operation²⁹. Using these data, approximately 267.2 kW/acre can be transferred. If the system is used for 75% of the year, and 30% of the land surface area is used in geothermal heat pump systems (heating or cooling mode) then as much as 6.557 x 10⁹ kWh are available.

The close proximity of the Detroit River and its width, depth and flow rates suggest that it could be an energy source using submerged river turbines.³⁰ If a 10 megawatt system were installed in the Detroit River, comparable to the system put in the East River in New York City, and then it is possible to harvest 6.745 x 10⁷ kWh.^{31 32}

Southwest Detroit has over 100 miles of salt mine tunnels, approximately 1000 feet below the surface of the city. These mines are cavernous with tunnel roads 60 feet wide and 22 feet tall^{33 34}. Several of these passageways are currently unused. If only 40 miles of these chambers were sealed and filled with compressed air and then vented at peak demand periods through a turbine generator, as much as 1.229 x 10⁴ kWh could be available.

If each of these alternative energy systems were implemented as proposed then a total of 8.924×10^9 kWh, or a total of 3.213×10^{13} kJ would be available. A typical medium-sized coal-fired power plant of 800 MW produces approximately 2.426×10^{13} kJ annually (assuming a two week maintenance shut down each year). These data suggest that alternative energy systems can provide a significant, if not *all* of Southwest Detroit's energy needs.

CONCLUSION

The Ford grant has allowed the Team to advance its pedagogic and design research objectives. The project is still in process, and results are expected in 2011. However, the project has already raised awareness in the community and city around issues of sustainable urbanism. While the Team is currently focused on the post-industrial city and Detroit serves as the context for the first application of Ci, but we believe that the design methodology is scalable and replicable to empower the sustainable design of other urbanized regions across the globe. The Ci methodology begins with mapping data sets associated with each urban setting, so we believe our methodology takes into consideration the unique geographic, climatic, and cultural differences of cities and their associated urbanized regions, creating a strong foundation for analysis, design and policy recommendations. Our digital interface and methodology could become an important decision making tool for the creation and perpetuation of sustainable neighborhoods, communities and cities worldwide.

ACKNOWLEDGEMENTS

The Team would like to thank the Lawrence Technological University College of Architecture and Design's administration for our research space and equipment, the Southwest Detroit Development Collaborative, Southwest Detroit Business Association, Urban Neighborhood Initiatives, Southwest Housing Solutions, fellow community members and the Ford Motor Company Fund.

ENDNOTES

1. Excerpted from the REQUEST FOR PROPOSALS (RFP) FORD COLLEGE COMMUNITY CHALLENGE, Ford Motor Company Fund, Dearborn, Michigan, March 19, 2010: "The Ford Motor Company Fund is reaching out to colleges and universities to request proposals for a third round of an innovative grant-making initiative: The Ford College Community Challenge (Ford C3). This one-time special program seeks to work with partner higher education organizations to catalyze community-building projects that address pressing local needs
As in previous years, the overarching theme of the Ford College Community Challenge is "Building Sustainable Communities." At Ford, we understand that to be a truly sustainable organization, we must play an active role in the larger community, helping to address a wide range of vital issues from education to safety to mobility. Ford Fund hopes to support our partner colleges and universities as they design and develop programs and initiatives that address critical community needs in new ways, with a focus on helping the community become a more sustainable place to work and live. While we realize incorporating this new feature will be challenging, it is our hope that participating schools will find their creativity and resourcefulness engaged in meaningful and unexpected ways."
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14. www.modelur.com
15. <http://www.masdarcity.ae/en/index.aspx>, <http://www.oneplanetliving.org/index.html>; Masdar City will be 6 sq km zero-carbon and zero-waste sustainable development, located within a short distance from downtown Abu Dhabi. Masdar City will be an emerging global clean-technology cluster located in what aims to be one of the world's most sustainable urban development's powered by renewable energies. Masdar City will be designed for a wide spectrum of uses including: residential, light industrial, business centers, researchers and development, academia, creating an international hub for companies and organizations focused on renewable energy and clean technologies. The first phase of construction began in 2008 and is nearing completion.
16. Developed by Bioregional and WWF. These are: zero carbon, zero waste, sustainable transport, local and sustainable materials, local and sustainable food, sustainable water, natural habitats and wildlife, culture and heritage, equity and fair trade, and health and happiness.
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33. Web site: <http://www.detroit salt.com/home.htm> (last accessed 1/3/2011)
34. Web site: <http://www.geo.msu.edu/geogmich/saltminingM.html> (last accessed 1/4/2011)

Does size matter?—Considering the importance of size and scale in educational environments

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ABSTRACT:

When creating environments for children, adults inevitably face the question of scale. What are the needs of the users? How high or wide should rooms be to instill a feeling of security and a sense of being sheltered by their small users? Does the provision of spaces suitable for children call for miniature environments or does the possibility to experience and explore spaces and furnishings at a variety of scales offer an important learning opportunity for children? How can the potential of educational buildings to function as a three-dimensional textbook and as a teaching and learning tool be fully embraced (Taylor, 2009)?

Architecture acts on our senses in many different ways: We do not only see the space, we feel it with all of our senses. We hear the different resonances or echoes depending on the size of the space and the materials used to build and finish it. We understand the distinctive tectonic properties of materials, their size and functions. These are important experiences for children who explore their world. Perception is an active procedure involving all of our senses, while the brain simultaneously processes numerous pieces of information (Guski, 2000). All this creates an overall understanding of the situation in time and space and trains the child's skills. Especially at a young age vestibular, kinesthetic, and somatovisceral senses mature (Walden, 2009). In an ideal world, every school and kindergarten would provide a balanced level of stimulation while reducing stress factors and disturbances to a minimum and allowing the users to physically use, explore and appropriate their learning environment.

This study will introduce several examples of schools and kindergartens where the architecture successfully adds to the curriculum in a way that the space helps to develop all human senses in the children and their perception of scale in the environments they are using.

CONFERENCE THEME: On Measurement

KEYWORDS: Scale, perception of space, educational environment, children, learning opportunity

INTRODUCTION

Recent debates about education—in the US as much as in other developed countries—have tended to analyze failing academic performance through a socio-economic evaluation of students' lives. However, the physical setting in which students are placed can also play a vital role in the overall success of the educational mission. When creating environments for children, adults inevitably face the question of size and scale. Is a smaller school to be preferred over a large one? What implications have the size of the administrative unit on the building itself and does this have an influence on how students perceive and connect with their schools? Does the provision of spaces suitable for children call for miniature environments—or does the possibility to experience and explore spaces and furnishings at a variety of scales offer an important learning opportunity for children? How high or wide should rooms be to instill in their small users a feeling of security and shelter? The question of size and scale in educational facilities has to be considered on a variety of social, psychological and physical levels. We need to recognize that a child's sensual perception is usually much more subtle and alert than commonly perceived and architects, designers as much as decision makers and parents have to be aware that "early perceptions imprints influence later perception habits." (Petermann, Menzel, 1997, p. 61). Childhood experiences of place and space are essential to the child's cognitive and social growth and their (independent) exploration is closely linked to the development of both self-concept and identity (Spencer, Blades, 2006).

I. HOW CHILDREN PERCEIVE THE WORLD

I.1. THE STAGES OF CHILD DEVELOPMENT

Piaget and others have clearly demonstrated that a child's development is directly linked to its ability to interact with its environment. Children develop an understanding of themselves through their interactions with events and materials outside themselves (Piaget, 1951). All educational environments have the ability to contribute or retard this process. Olds states "the motivation to interact with the environment exists in all children as an intrinsic property of life, but the quality of the interactions is dependent upon the possibilities for engagement that the environment provides" (Olds, 1979, p.91). Thus the school, as the "workplace" for children during significant stages of their development, is of tremendous importance.

Piaget distinguishes four different stages of childhood development that are pertinent to an analysis of educational space (Piaget, 1951; Singer and Revenson, 1978):

In the first months the child perceives and understands the world exclusively through perception. Sensual experiences and reflexes stimulate the development of gross motor skills as the child learns to roll over, sit up, crawl, stand, walk, run and eventually climb. Simultaneously the fine motor skills progress with increasing locomotion and allow small children to use their hands or grasp small objects with growing precision while they start exploring their surroundings. The interaction with the built environment is immediate, though the concept of space is not fully developed.

Between the ages of 2 and 7 children practice their motor skills through various forms of play. With the acquisition of language a new developmental stage begins and the importance of social interaction grows. This phase is characterized by curiosity but also by an egocentric perception of the world. At this age the child knows the world around it only through its own limited experiences and attempts to explain everything by own vantage point. At the same time this age group becomes more independent and usually has the urge to explore independently. The understanding of the world grows and the concept of space continues to develop. Slowly but steadily the child learns about space and spatial concepts.

In the concrete operational stage children begin to reason logically but are still rather concrete in their thinking. Slowly they discover the difference between perceived and relative scale and space. Between the ages of 7 and 12 a child can have conversations and think logically but still needs practical aids to develop its reasoning. This is the time when most children go to school on a daily basis. Social engagement with peers is intense and children continue to develop their motor skills. To do this, they often undertake tasks that may be described as daring and adventurous--the child continuously pushes its skills and limits. Successful mastery at these tasks helps to build self-esteem and overcome fear, and encourages the child to continue to grow. An environment that stimulates and offers a wide variety of spatial situations and experiences can be especially beneficial in this stage. However, at this time child sizes and development also vary greatly, especially due to age and sex. This demands special consideration by designers, as we have to be aware that the same solution will not be adequate for all users.

When entering the age of adolescence, the child enters the fourth stage. Between the ages of 12 and 16, the child passes the stage of formal operations and gains the ability to understand more abstract concepts. It is able to use formal operational thought, which enables it to think about the future, the abstract, and the hypothetical while clearly living in the present. The new abilities allow the adolescent child to think more flexible, solve problems through deductive reasoning, abstract thinking and systematic problem solving. Simultaneously the horizon of the child expands and the urge to explore beyond the known boundaries affect further development and social interactions. Peer acceptance and socializing with friends becomes continuously more important. An adolescent youth wants to be considered a grown-up and equal to adults. This should also be considered for their appropriate learning environment.

1.2. THE PERCEPTION OF SPACE WITH ALL SENSES

Architecture acts on our senses in many different ways: we do not only see the space, we feel it with all of our senses. We hear the different resonances or echoes depending on the size of the space and the materials used to build and finish it. We understand the distinctive tectonic properties of materials, their size and functions. These are critically important experiences for children who explore their world more intensely while they gradually develop a more holistic concept of space. Perception is an active procedure involving all of our senses, while the brain simultaneously processes numerous pieces of information (Guski, 2000).

Bishop describes the importance of the sensory quality of the environment and identifies key factors architects and designer should acknowledge:

The textures, the colors, the smells, the sounds in the space, and the lighting qualities are all features to be considered as tools to be arranged in a variety of combinations to create a sensory-stimulating environment. A sensory environment is one that (1) acts with and nourished all the users' senses deliberately, (2) has sensory qualities and sensory signposts used as part of all the chief functions of a play environment and the creator has consciously and consistently supplied sensory information in this way, and (3) has made the most of its natural advantages of location and then continued to add sensory detail, conscious of what these features are adding to the overall experience within the environment. (Bishop, 2004, p. 234).

Our five senses provide us with important information on our environment. While we are usually aware that we see space, touching, smelling, hearing and sometimes even tasting a space also provides us with particular pieces of information on our environment. Many of these pieces of information are processed unconsciously.

The human brain has the ability to select and organize this information into stable, recognizable images of places, which we interpret in terms of our shared cultural experience. Equipped with concepts and categories, we fit our raw sensory experience, like pieces of a puzzle into a meaningful whole. (Farbstein and Kantrowitz, 1978, p.8)

The sensory perception of space is also connected to the sense of equilibrium (vestibular sense), of movement (kinesthetic sense) and the somatovisceral senses that control bodily functions. All of them are "significantly involved in the perception of architecture" (Walden, 2009). They influence how we perceive a building and how we feel when we use it.

Adults usually have substantial experience in sensing their surrounding. Understanding and navigating even unknown environments has become a second nature to them. Children are still in the process of acquiring these skills. At the same time their perception is more alert and they are more sensitive to sensory impulses (Guski, 2000; Walden, 2009). They are building up their own repertoire of experiences in order to advance their overall understanding of the world in space and time. Thus the kind of direct interaction the spaces used and experienced by children afford have a critical role (Bell, 2006). Offering a variety of experiences and spaces in a range of perceptual and relative sizes and scales helps children to develop a multitude of cognitive and sensory skills. For that reason, spaces we experience in our childhood are of special importance and can influence spatial preferences as well as decision-making processes.

1.2.1. Tactility and vision

Humans decode space predominantly through a combination of tactility and peripheral vision. Vision dominates the other senses in the Western world and often is the sense we rely on most. Light reflects from surfaces and gives us information on shape and scale, colors, materials and textures, other people who might be using the space and activities that are going on. We visually evaluate distances or heights as well as other perceptual and relative spatial qualities. A child gradually learns the concepts of space and understands that what it sees is one piece of information that is complemented through perceptions of the other senses. At the same time we have to remember that decisions on the dimensions of space, furniture or equipment should be based on the scale of children and their anthropometric data. The average height of children, the reach of their arms and length of their paces as well as the angle of vision differs significantly from those of adults (Walden, 2009).

Construction materials and surfaces for school buildings should be carefully selected for the intended use. They are exposed to a lot of wear and thus it is vital that they age well, demand little or no maintenance and can be replaced easily if necessary. As schools are usually built on a tight budget, any unnecessary cost has to be avoided; nevertheless attention must be paid to good quality and durability as well as to their sensory and conceptual qualities. Certain building materials like brick or timber reveal some of their structural “duties” and can help the children understand how a building works, as they might be familiar with their general concept of these materials from building block towers or stick figures. Materials can support the potential of educational buildings to function as a three-dimensional textbook and as a teaching and learning tool (Taylor, 2009). At the same time a child can more easily relate to materials they know from their home environment. They can have the air of familiarity while at the same time introducing a sense of scale and texture.

Surface qualities of materials and their textures give important clues to the user about how to use certain spaces, areas or furnishings. They usually complement the visual impressions.

The textures, colors and forms applied to all the surfaces of the environment are the close-at-hand qualities of the environment with which occupants come most in contact, and what they “read” continually in experiencing a setting” (Olds, 1989, p.10).

The material choice in the true sense of the word is tangible with partially interesting tactile qualities. A soft carpet might invite children to sit, lie or play on the floor while a hard, cold stone floor in an adjacent area indicates that it would be used for circulation space (Denton and Smith, 2010). Soft materials and padding, especially on furniture, create a welcoming atmosphere and invite children to use them in a very direct way. These can also provide the needed spaces of shelter when a child needs to retreat for a while from the group.

The color of materials or finishes dominates the general impression of the school in many cases. Contrasting materials as well as color accents can spice them up. Painted surfaces can complement the material appearance or may be used as accents with strong colors for a few details only. An architectural language that is rather reserved and displays a clear and low-key appearance is characteristic to many well-designed schoolhouses. Limiting the design to only a few major materials, chosen for their properties, give the schools a distinct character while providing spatial clarity. While some researchers claim that carefully chose color schemes can influence student behavior, attitude and learning concentration (Sinofsky, Knirck, 1981; Gimbel 1997) no quantitative data has been published to verify this (Martin, 2006). Walls in the schoolhouses should be painted in neutral or muted tones. There is no need to artificially “sweeten” the architecture with cute details and “child-favored” colors. It is more important to provide a calm backdrop that allows the users to appropriate their environment with their own art and to avoid the danger of overstimulation and business. Once the children have conquered their space there will be plenty of color and play.

1.2.1 Acoustics

Sound is another important factor of how we experience a space. All environments--especially spaces in large institutions--are filled with sound. While this adds richness and supports the perception of a socially active space, sound can create distraction and discomfort. Sound intensity, localization and orientation also help us understand spaces (Gibson, 1966). The child needs training in order to learn how to identify the source of sound waves that reach its ear and also to distinguish meaningful from accidental sounds. The student needs to learn how to identify e.g. the voice of the teacher and listen to him while ignoring background noises. While adults can often deduce words they miss in a sentence, children have only limited capabilities to do this due to their limited vocabulary. A classroom with bad acoustics may have an enormous influence on the students’ learning performance (Ledford, 1981; Crandell and Smaldino, 2000; Martin 2006). Not being able to understand the explanations of the teacher or what classmates are saying is not only a fundamentally frustrating experience but deprives the child from absorbing important information. The noise level of a space needs to be adequate to its intended use and has to be designed appropriately. Sound reflection and reverberation have to be carefully studied in classrooms as well as in common areas and designed to support the intended use. The proper choice of surface materials can go a long way--which again ties into the tactile considerations previously discussed.

However, muting the school environment too much and creating acoustically dead spaces can also be a detriment. Especially young children or those with disabilities usually enjoy experimenting with creating sounds. The observation of the echo of a sound the child has produced--the audible response and grasping the concept of cause and effect is an activity that can be easily implemented and is rewarding to the child. It is part of exploring the world. Activities involving sound can trigger the interest of children. Experimentation can be encouraged "when the sound responses are more musical or have a greater range of tones than when a single noise or note is issued repeatedly from the activity." (Denton and Smith, 2010)

1.3.A BALANCE BETWEEN STIMULATION AND SPACE FOR CONCENTRATION

A child's environment should provide "peaceful, but invigorated balance" with "sameness, predictability and contrast, stimulus" (Day, 2007). Offering a safe and reassuring base while providing stimulating challenges and possibilities is essential. Educational surroundings can play a key role in the cognitive, physical, emotional and social growth of the student and the influence of different spaces on the children has to be considered in order to provide an optimal learning environment. All this creates an overall understanding of the situation in time and space and hones the child's skills, especially at a young age when vestibular, kinesthetic, and somatovisceral senses mature (Walden, 2009). In an ideal world, every school and kindergarten would provide a balanced level of stimulation while keeping stress factors and disturbances to a minimum. This would allow the children to physically use, explore and appropriate their learning environment. A building for children should exhibit "difference within sameness" because "children are attracted to environments that promise mystery and new information in a safe and predictable setting" (Stewart-Pollack and Menconi, 2005). Grounded on this basic understanding we will now take a closer look at the school--as an institution and as a building with architectural features.

2. CREATING A VARIETY OF SPACES

2.1.A SENSE OF SECURITY

In order to provide a positive learning outcome it is important that the schoolhouse should be a place that instills a sense of security in the children. While it is difficult to isolate, quantify and measure the impact of the physical space on learning outcomes and performance it has been recognized that educational spaces are of high importance (Clark, 2002; Dick, 2002; Martin, 2006). Maslow states a series of basic needs that mark the stages of human development and growth. This "Hierarchy of Basic Needs" is also applicable to children and has a strong influence on the healthy physical and intellectual development of any human being. But how does architecture address these?

The built environment mostly caters to the first level (physiological needs) and the second level (the need for safety): providing shelter and a secure and stable environment. Architecture can also provide spaces that support social interaction and give the children a sense of belonging and a place to be with friends. Only once all the other needs have been sufficiently satisfied will a child start building self-esteem and pursue self-actualization or independent growth.

The Dutch architect Herman Hertzberger, renowned for the superb quality of his school buildings, requests that a school should have a residential atmosphere and appearance rather than an institutional one. He stresses the importance of the learning environment to have a familiar scale, to be "constant and readily identifiable" (Hertzberger 2008). At the same time, school prepares the child for a life in the world and has to instill curiosity and courage to venture beyond the known boundaries. The importance of providing social spaces that foster interaction is important.

A school with spaces on different scales offers children the possibility of simultaneously gathering different spatial experiences and of experiencing themselves within the constructed environment (Bell, 2006). All senses are addressed here: The echo of one's own voice or the reverberation of footsteps in an empty, big hall is a different acoustic experience than the reverberation in a small, sound-insulated room. Crossing a bridge between two buildings can convey a sensation of height; narrow walks or low rooms have different effect than wide and high ones. Tactile experiences of

different surfaces, too, or the different smells of the materials used can be definitive and beneficial for wellbeing inside the rooms. Used in a targeted or tightly controlled manner, spatial divergence and change will contribute to a stimulating learning and working environment.

Despite offering a variety of different spatial situations, schools should be clearly organized and open (Martin, 2006). The general effect of the architecture on its users is closely connected to the final design of the individual rooms and their degree of detail. The variety of high and low, protecting and spacious room sequences within every school should be experienced as pleasant but not unsteady or busy. A good school provides an atmosphere that is at once sheltering and simultaneously open by its spatial generosity. As the needs of children change with their age and maturity, so do their spatial needs. For learning environments that are used mainly for primary level teaching a good solution is a rather warm and protecting atmosphere, reminiscent to some degree of the familiar home. School buildings for older occupants, on the other hand, should have a more solemn, neutral air and offer the students a learning environment that is similar to adult workplaces.

2.2. DOES SIZE MATTER? – THE SCHOOL AS ADMINISTRATIVE UNIT

In the U.S. and in many other countries the trend throughout the second half of the 20th Century was to create large schools. This affected the educational unit as much as the educational building. Schools grew bigger while the number of elementary and secondary schools declined by one-third (Walberg 1992; Howley 1994). Simultaneously enrolment numbers grew by 500 percent. While rural schools remained small, educational facilities in urban settings often now have several thousand students (Cotton 1996). This allowed school districts to bundle their resources, combine facilities and amenities in one location and often under one roof, and streamline organization and administration of educational facilities. However, what sounds like a perfectly sensible thing to do can reach a critical point: While large school complexes have the advantage of providing a wider variety of activities, services and curricular options to students, faculty and staff, they also have disadvantages. Research has shown that both the size of the school and the size of the classroom has a significant impact on academic outcomes (Moore and Lackney, 1994, Martin 2006). The most obvious are higher levels of anonymity and a lessened sense of community resulting in places that feel more like learning factories than schools. This often results in lower student performance, social and behavioral problems and a rise of aggression and vandalism (Cotton, 1996; Lackney, 2000; Maxwell, 2003; Bergsagel et. al. 2007).

The British anthropologist Dunbar suggested that the number of people with whom one can maintain stable social relationships lies at around 150 (Dunbar 1992 & 2003). In this group size it is still possible that the individuals know each other, relate to one another and form one cohesive unit that is socially balanced. Larger groups usually require more restrictive regulations and formal organization while they are at the same time more prone to develop internal difficulties. In many cases a return to smaller administrative and physical units for schools is economically not feasible. Still the problem of overly large schools has to be addressed. As one alternative, however, the organizational and physical separation of large schools into Small Learning Communities has been successfully implemented in the last decade – even when no new school building was provided. It is not a coincidence that today's trend towards Small Learning Communities (SLC) or "Schools within a School" operate with similar group sizes as recommended by Dunbar, breaking up the large social scale of the educational entity into smaller units.

Creating SLCs within larger buildings is one option and sometimes is done by just accommodating them on one floor or housing them in separate parts of the same schoolhouse. To create these smaller entities results in a number of positive factors for which Cotton (1996) summarizes some of the most important ones:

- A tight social network among students and faculty that creates an atmosphere of responsibility (for one another, the own learning progress as well as for the provided resources) and inclusion.
- Better social identification with the group (in this case the school community), which prompts higher involvement in school activities.

- This again results in a higher level of parent involvement.
- Student and faculty have a heightened sense of efficacy.
- There is a general sense of the school as a safe haven, a place where the users like to spend time.
- The teaching is often delivered in a student-centered mode with individualized and often experimental learning activities that are relevant to the world beyond the classroom.
- Class sizes are frequently smaller.
- Both the curriculum and the teaching methodologies are more varied and cater in a special way to the individual needs, often fostering project-based group work that enables students to not only expand their academic but also their skills.

In brief, if the atmosphere within the school is more personal, people will respect and consider one another when the school community is recognizable as a smaller entity (Moore and Lackney, 1993). Students and faculty in small school or small learning communities feel accepted, perform better and show a higher level of engagement and participation (Maxwell, 2003). While in most cases a school will have more than 150 students, the grouping of classes into larger groups within the school community has been a successful concept to create smaller communities of learners within large institutions. The versatile demands of schools require this building type to offer a broad range of spaces with different atmospheres and spatial qualities. At the same time this allows the child to experience a variety of social experience that can be carefully adjusted as social skills develop and the child grows more independent.

2.3. SPATIAL ORGANIZATION OF SCHOOLS

While the primary function of a school building is to support educational processes regarding the students intellectual and cognitive development, it is also an important training ground for social and cultural skills where children are prepared for adulthood. A multitude of spaces is needed that provide good environments for the many areas of growth and learning, all fitted into the larger system of spaces (Martin, 2006). The overall orientation within the school building as well as the differentiation of distinct functional zones clarifies the hierarchical order, facilitates way finding and helps to distinguish areas for different uses more easily. To this end it is important that the users can form mental maps or images to create a connection between the self and the environment (Bell, 2006). Lynch describes the city in his book the *Image of the City*, and the same concept is transferable for schools:

Environmental images are the results of a two-way process between the observer and the environment. The environment suggests directions and relations, and the observer—with great adaptability and in the light of his own purposes—selects, organizes, and endows with meaning what he sees. The image so developed now limits and emphasizes what is seen, while the image itself is being tested against the filtered perceptual input in a constant interacting process. (Lynch, 1993, p.6)

In most schools different zones of use can be identified easily. The spatial sequence and the appropriateness of the scale for public areas (e.g. atrium, cafeteria), semi-public zones (e.g. shared zones within groups of classroom) and the mostly private areas of the classrooms itself should be rich in contrast. In the best cases they range from wide rooms with high ceilings that are used for events with large groups, for social events, sports or for theater productions via medium size spaces used simultaneously by mid-sized groups of users down to small and intimate rooms, which are used by small groups or individual students and teachers for different teaching purposes. The scale of the spaces clearly determines their character and function. “Physical and spatial aspects of a learning environment communicate a symbolic message about what is expected to happen in a particular space.” (Martin, 2006, p. 93).

A clear hierarchy of spaces is very characteristic for many schools. Today schools are broken up frequently into clusters of classrooms, which are grouped around a common shared atrium or other assembly area where the school community as a whole can come together. The central space--often spacious with good visibility from all parts--is the most public area of these schools. It usually serves

an important social function (i.e. as cafeteria or auditorium) and is closely tied to resources shared by the whole institution (gymnasium, library, computer laboratories, workshops) (Altenmüller, 2008). It is this space that connects the school, physically and ideologically, and is frequently used by the neighborhood community for other purposes outside of school hours. Consequently it functions as the threshold between the sheltered school environment and the world outside.

The physical arrangement is of high importance to classroom performance and behavior (Martin, 2006) and Gifford (1987) states that the classroom layout itself affects the social interaction between instructors and students. In contemporary schools it has become common to organize the classrooms in clusters, combining a group of classes into larger communities of learners. These teaching spaces are again organized around a central space that is visually connected to the classrooms. In ideal cases it is large enough to gather several classes at once and equipped with furniture that allows a variety of activities connected to learning and socializing. This space is an extension of the classroom and allows the circulation area to double as a work zone during instructional time and an area for social interaction during breaks. The space between this work or circulation area functions like a threshold, providing articulation and important spaces in-between rather than closing them off. It is at the same time transition and connection between places with overlapping functions. The classroom can extend out into the shared space, making the space for education larger rather than smaller (Hertzberger, 2008).

The classroom itself is the most private area and serves a manageable number of students and one teacher that forms a social entity. Familiarity among the members of the group develops quickly and the group interacts with other units nearby. The classroom serves as a home for the group – a space that is designated to this select number of people and can be appropriated accordingly. Hertzberger calls the classroom also “the home base” and later “the nest from which you can take off and you keep returning” when exploring the world (Hertzberger, 2008, p. 35). The classroom needs to provide space for a variety of learning settings, for group activity but also for individual and self directed explorations. The “articulated classroom” suggested by the Hertzberger offers a variety of zones that support different activities while providing an increasing degree of privacy and protection but without breaking up the space inwardly. The scale of these spaces gives clues about how they function best and the children quickly figure out what area they prefer for which activity.

2.4. RE-SCALING EDUCATIONAL BUILDINGS

How does this knowledge influence the architecture of schools? A simple comparison of the physical height of the user to the height of the building might already give us a first clue about how enormous a multi-storey school building can appear to a young child. To counterbalance this enormous difference in scale and provide an environment to the students that feel safe and protected it is necessary to provide an array of spaced of different scales, dimensions and heights; to break up large buildings in differentiated building parts that allow for easy orientation and identification of use and purpose that cater to the varied needs of their users.

We have to keep in mind that children work, learn and interact differently from adults and that their need for privacy also differs. While very young children do not yet have a strongly developed sense of privacy, these needs change with age (Walden, 2009). Children “live in the moment” and can retreat completely into their own imagination when they need to. Consequently, “privacy for [children] does not necessarily require solitude” (Stewart-Pollack and Menconi, 2005). The school design should cater to these needs by providing a variety of zones and settings. Break-out areas, niches and more secluded spots that are still connected to larger spaces can provide an ideal solution that allow students to withdraw from the group without feeling detached or isolated. Providing the small, somewhat enclosed spaces that are favored by children can allow them to withdraw into their imaginative world. These spaces “represent protection from the outside world” while instilling sense of belonging to a certain place (Stewart-Pollack and Menconi, 2005). Flade requests that “environments for groups should be designed in such a way as to permit control of privacy on the individual level as well as for the group” (Flade, 1998, p.58) and Walden adds to this that “every user of a public building, every student, every teacher should have the opportunity for such a retreat into a zone of relative privacy” and “if there is no opportunity for retreat, this will certainly affect human wellbeing” (Walden, 2009, p.92).

Numerous studies have shown that crowding correlates with stress symptoms, negative emotions and can lead to aggression and diminished productivity (Gifford, 1987). However, we need to remember that the objectively measured density might vary from the subjectively perceived crowding (Walden, 2009). At the same time a careful balance needs to be found as both too high as well as too low density can have a negative effect on the students, which underlines the importance of providing appropriately scaled spaces for the respective use and number of users. While in most cases the architect will not have control over class sizes or the number of students using a particular space at a given time, considering privacy needs throughout the design process and providing opportunities for “restorative privacy,” will counter-balance and prevent that “the [students’] cognitive and social development may suffer as a result” (Stewart-Pollack and Menconi, 2005).

CONCLUSION

School architecture can successfully contribute to the educational process by encouraging childhood sensory development. Understanding the actual stages of childhood development as well as how spatial perception functions and evolves can give architect and interior designers important clues to develop adequate learning environments. Consideration of size scale in school design is crucial at various levels (Walden, 2009). At an institutional level it is now widely accepted that a small learning community is advantageous for the learner. It provides a better social environment that results in a more supportive learning atmosphere (Cotton, 1996; Lackney, 2000; Maxwell, 2003; Bergsagel et. al. 2007). To cater to the students needs the building itself should be adequately articulated. At a concrete spatial level a variety of spaces with a range of different attributes offers numerous opportunities to stimulate the senses, which impacts cognitive, emotional and social growth in a positive way. It is generally accepted that inadequate or poor learning spaces affect the physical well-being and performance of teachers and students (Schneider 2003) and that the physical settings has a major impact on social interaction and academic outcomes (Schneider, 2002; Martin 2006). Material choices and furnishings can help to mediate the scale and create a positive environment that is suitable for children.

In the US the design and construction of school buildings is usually still driven by economical limitations without sufficiently considering the academic goals and principles of an institution, without sufficiently considering that teaching and learning strategies have changed in today’s information society and without sufficiently recognizing the needs of their users. Too many new schools are based on outdated social and spatial concepts that catered to a different society. While it is not necessary to create miniature worlds for students, it is more important than ever to provide learning environments that foster independent learning and social interaction, that at the same time provide a place of security and shelter while offering a variety of platforms to stimulate social, psychological, intellectual and physical growth.

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Transformative architecture for the shrinking city

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ABSTRACT

Many cities such as Detroit and Cleveland have been shrinking over the past decades. As cities shrink there is a weeding out of inefficiencies in businesses, social venues and in occupied spaces. When growth returns, the perforations in the urban fabric become the spaces for growth opportunities.

There are over 4.6 million commercial buildings in the United States housing nearly 70 billion square feet of floor space. Most do not meet ASHRAE Standards for thermal comfort, ventilation and energy efficiency, due to age. The embodied energy in each of these buildings is enormous. Replacement of outdated buildings is not only a loss of this embodied energy, but requires additional resources for the disposal of the demolished structure. A shrinking city has an abundance of outdated buildings at low prices creating opportunity to replace the concept of urban re-growth with that of transformation.

Transformation is different than restoration or renovation in that it does not necessarily strive to maintain the social, political or cultural embodiment of the place. Transformation allows a sustainable update with a new concept for user encounter. The idea of building replacement is the economical choice at present not due to the merits of replacement but rather due to the lack of research into the transformation of existing structures into sustainable environments.

While new methods and materials are important, the idea of building on a virgin site has passed its time. Exploration into the retrofitting of existing buildings with new program and updated sustainable systems is important and preferable to development of urban pockets or brownfields.

This paper will discuss the need for transformative architecture in research. Examples of transformative projects highlighting success and failures will be reviewed. The paper will provide a basis for discussion of the development of transformative ideas for practicing architecture firms.

CONFERENCE THEME: Ecology, Sustainability, and changing societal and political economies

KEYWORDS: sustainability, shrinking cities

THE SHRINKING CITY

Many cities such as Cleveland have been shrinking since the mid-twentieth century. Largely due to the decline of the American steel industry, most rust-belt cities have returned to population numbers not seen since the 1920s.¹ Cleveland began a rapid growth trend in the early twentieth century reaching a population of 900,000 by 1930. The city was able to maintain this population through World War II and the post-war building boom, but numbers have been falling since that time. From 914,808 in 1950, the population of Cleveland in 2009 had dropped 53% to 431,369.

While Cuyahoga County, home to Cleveland, has seen a population decrease of 8.5% over the past decade alone, the City of Cleveland population has decreased 9.8%. According to census data posted on the City of Cleveland planning site² (figure 2) the Metropolitan Cleveland area has seen slight growth during this period. What this data implies is that the city is de-centralizing but has an opportunity for re-growth, albeit slow growth as indicated by the increase in population of the surrounding counties.

The continual decline has left Cleveland with an urban landscape perforated with vacant lots and brownfields. On October 4, 2010, The Cleveland City Council passed amendments to the zoning code³ to include urban agriculture as a principle use for vacant residential lots. The BioCellar⁴ Project led by Terri Schwartz at the Cleveland Urban Design Collaborative plans to use foundations left by some of the eighteen hundred vacant dwellings scheduled for demolition in the upcoming year. These foundations will be converted to greenhouses, compost stations and fisheries in an effort to stave the decline of property values and social order in Cleveland neighborhoods.

Although the group is still negotiating funding for the first BioCellar, Figure 3 shows the possible impact and relatively uniform dispersion of Biocellars throughout Cleveland, indicating that the loss of residential units is not particular to one area.

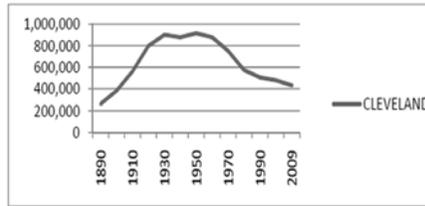


Figure 1: Population in Chicago, Detroit and Cleveland in the 20th century. Source: www.census.gov

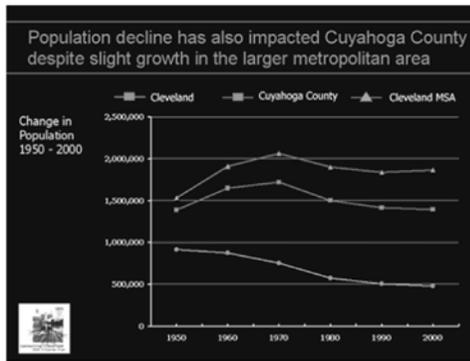


Figure 2: Population decline in Cuyahoga County. Source: Planning.city.cleveland.oh.us

Shrinking cities struggle with a vicious circle of tax base loss causing tax rate increase causing emigration causing tax base loss... And while the loss of 1800 homes in the next year is cause for concern, it is less than 10% of the total number of homes in Cleveland. The commercial sector in Cleveland has taken a harder hit. According to a study by Grubb & Ellis,⁵ 23.5% of commercial real estate in Cleveland was vacant at the end of 2010. Further, five large tenants, occupying over 811,000 square feet in downtown Cleveland have leases expiring soon. Three out of the five reported to the Plain Dealer⁶, Cleveland’s newspaper, that they are considering the possibility of new construction, and not necessarily within city limits.

Predictions of a return to cities coincide with predictions of de-centralization. Herzog⁷, in his book “The Return to the Center” states that:

“One category of work in planning and urban design in the second half of the twentieth century involved the search for ways to rescue the “sense of place” in cities...but “sense of place” is, at best, a vague notion, difficult to measure, and highly subjective. Yet, seemingly everyone would agree that cities with meaningful spaces are more stimulating than those that are homogeneous.”

Whether a prediction of return or a prediction of further de-centralization or even a prediction of the urbanization of suburbia is accurate, Herzog’s simple observation that cities with more meaningful spaces are more stimulating indicates a course of action for rustbelt cities such as Cleveland.

As cities shrink there is a weeding out of inefficiencies in businesses, social venues and occupied tenant spaces. It begins slowly with the departure of a company with a large number of employees and significant lease space in the city. When the employees leave, support businesses such as restaurants and merchants suffer. Those businesses most highly impacted are those in close proximity to the new vacancy and that operate with a low profit margin.

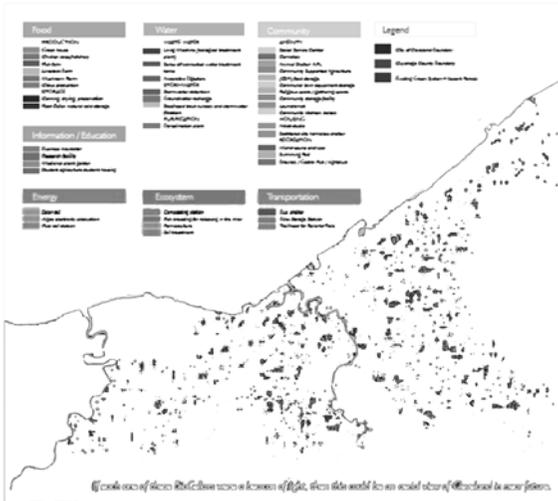


Figure 3: BioCellar proposed use map Source: Paul Vernon, Cleveland Urban Design Collaborative

If growth returns, however meager the rate may be, the perforations in the urban fabric become spaces for new opportunities. Unfortunately, not all growth occurs in vacant building space. Consider the implications of building replacement in a city with a declining population or very slow growth rate. On one hand, new buildings create construction jobs, add to the tax base and create a sense of prosperity that helps the image of the city. The downside is that when the growth is not true growth, but merely a relocation of existing businesses into new buildings, the temporary surge in construction jobs and boost to the tax base is offset by the creation of yet another vacant building. Vacant buildings not only pose a security threat, but they have an adverse affect on all the businesses in the area.

According to the University of Michigan Center for Sustainable Systems factsheet⁸, there are over 4.9 million commercial buildings in the United States housing nearly 72 billion square feet of floor space. Most of these do not meet current ASHRAE Standards for thermal comfort, ventilation and energy efficiency, mainly due to date of construction. A building built after 2010 will be designed to use half the energy of a building built 35 years earlier.⁹ Further, the embodied energy in each of these buildings is enormous. Replacement of outdated buildings is not only a loss of this embodied energy, but requires additional resources for the disposal of the demolished structure. A shrinking city has an abundance of outdated buildings at low prices making it a place of opportunity to replace the concept of building replacement with the idea of transforming existing vacant or underutilized buildings and leaving the urban perforations to develop natural or alternative uses.

I. TRANSFORMATIVE ARCHITECTURE

Transformation by definition requires change. Transformative architecture promotes a change in use, a change in appearance, and a change in efficiency and sustainability. By recognizing that every city is constantly in flux at some scale as it reacts to economic stimuli and by judiciously employing sustainable strategies to affect positive change, transformative architecture becomes a means towards the attaining the next life of the city.

1.1 THE DYNAMIC VERNACULAR

Transformative architecture embraces the idea that the vernacular is dynamic. Just as language and customs defining a culture evolve over time, architecture also evolves. This constantly evolving vernacular can be seen in the timeline of any city. It can also be seen in the timeline of many

buildings not restricted by historical preservation. Kenneth Frampton, in writing about critical regionalism states

“In order to take part in modern civilization, it is necessary at the same time to take part in scientific, technical and political rationality, something which very often requires the pure and simple abandon of a whole cultural past.”¹⁰

In writing this, he was speaking of the problems facing newly developing nations, and yet, the same holds true for shrinking cities. As population dwindles and development is replaced by abandonment, the identity that a city once had is lost. In order to become a vital urban center again, the city will require a rethinking of its *raison d'être*.

Cleveland, no longer a steel center, has such an identity crisis. One strategy currently employed is to redefine Cleveland as a medical service and supply center. The Cleveland Medical Mart & Convention Center broke ground in January 2011 and is expected to be completed by 2013. This center, located on the mall in the heart of downtown Cleveland is predicted to revitalize the downtown area. How successful this attempt at revitalization will be is dependent on the nature of future development.

In seeking a new identity, Cleveland, like other shrinking cities, must let go of its past and allow its vernacular to transform. Transformation is different than restoration or renovation in that it does not necessarily strive to maintain the social, political or cultural embodiment of the place. Transformation allows a sustainable update with a new concept for user encounter whenever that update is necessary to the survival of the city.

1.2 LOCATION, LOCATION, LOCATION

The idea of building on a virgin site has passed its time. And while developing urban pockets or brownfields, most of which are thriving parking lots, is better than developing greenspace; a plausible condition exists in shrinking cities to justify conversion of parking lots to greenspaces or greenspace-covered parking facilities and reserving redevelopment to existing and preferably vacant structures. By doing this, this urban fabric becomes a patchwork of occupied spaces connected by greenspace rather than one of new buildings dotting a landscape of vacant buildings.

The idea of building replacement is the economical choice at present not due to the merits of replacement but rather due to the lack of research into the transformation of existing structures into sustainable environments. For redevelopment to take place in vacant structures, it must become economically feasible. To achieve economic feasibility, more exploration into the retrofitting of existing buildings with new program and updated sustainable systems is required. Updated sustainable systems, passive and active, require more than adding a second skin to the façade.

1.3 THINKING OUTSIDE OF THE DOUBLE SKIN BOX

Double skin facades have become the method of choice in many retrofits today due in part to the following. The addition of a second skin leaves the original envelope intact, preserving the history of the structure, saving on demolition costs and allowing for possible occupancy during the retrofit. Second skins rely on a thermal stack effect from the solar radiation collected to draw air around the original façade; a passive system.

Yet, in order to be truly effective, a second skin must enhance user comfort for all conditions specific to a site. For example, in a Cleveland winter a double skin should augment heat transferred to the building through solar radiation and deter heat loss from the building through the skin in cloudy and night-time conditions. In the spring and autumn, natural ventilation should be encouraged. In summer, minimizing of heat gain is necessary. Simply enclosing an existing structure in a glass box is not going to achieve optimal user comfort. The second skin will need to provide natural ventilation at specific times of year, adjustable solar shading, ease of maintenance and recirculation of solar radiation to the north side in winter; in other words, an active system.

The Occidental Chemical Building in Niagara Falls, NY is exemplary in multi-seasonal adaptability. Studies at the University of Waterloo¹¹ show a cavity temperature 14°C higher than outside temperature in the winter with dampers closed, but only 1°C higher in the summer with dampers open, exterior windows open and fan on. This indicates the a second skin could work well as a passive system. However, interviews with tenants found users were not thermally comfortable, due most likely to the fact that the louvers, intended to rotate for solar shading and nighttime insulation, had not been operable for the past 4 years. Because of reliance on a mechanical element, the double skin failed to create thermal comfort for the occupants. The double skin of the Occidental Chemical Building has a cavity depth 1.2m that allows room for maintenance workers to clean the space, and to allow for adequate air movement. It also has the luxury of a large open site. Although the building is referenced because it is located in a city with a climate very similar to Cleveland, Cleveland buildings have other challenges that hamper the design of a double-skin as a façade transformation. First, many buildings are constructed to the lot line and therefore do not have enough space to build a double skin without seeking to acquire sidewalk space from the city. Second, many buildings are not oriented properly to employ a double skin.

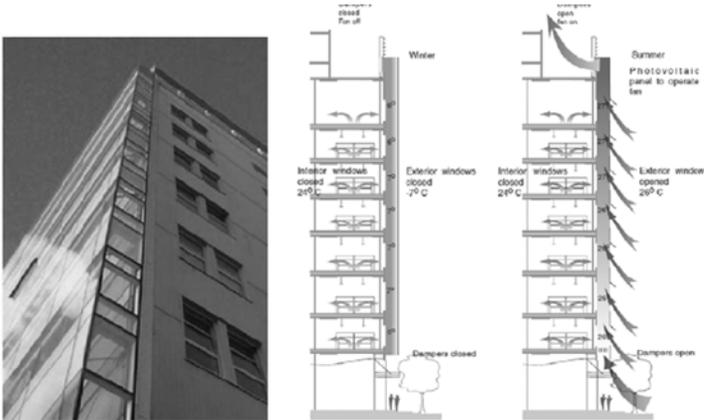


Figure 3: Double Skin Façade on the Occidental Chemical building. Source: The Tectonics of the Double Skin: Green Building or Just more Hi-Tech Hi-Jinx?

Why a second skin? Consider the idea of replacement skins for high rises constructed of stick or unit type curtain walls. Replacement of the curtain wall units can upgrade user comfort without adding to the weight of the façade or having to create a self-supporting second skin. The metal and glass from the existing skin can be recycled to reduce the carbon footprint of the upgrade. In such a case, new panels could offer natural ventilation, lower thermal conductivity, less air infiltration, solar energy production, rain water collection, and climate responsive shading strategies.

But is the cost of new envelope panels justified? If the largest heat transfer occurs through glazing, why not simply replace the windows? The Empire State Building¹² is undergoing a restoration in which a third pane of glass will be added during the re-manufacturing of its 6500 windows as part of a plan to reduce the energy consumption of the structure by 38% or 4.4million dollars annually. The windows alone are predicted to reduce the energy needs by 5%. The project reworks the R-2 double pane glass with “SeriousGlass”™ coatings which give the remanufactured unit an insulation value between R-5 and R-8. Simply rethinking the windows only provides a minimal reduction in energy costs.

Currently, at Kent State University, Adil Sharag Eldin, PhD and Hollee Hitchcock Becker are conducting research on climate responsive wall systems that employ a titanium foam structure immersed in a conductive fluid that relays input from both the interior and exterior environment to natural thermal regulators which present as veins and pores throughout the wall system. The Living Skin will be capable of adjusting temperature and oxygen levels without the use of an HVAC system. The development of responsive panels such as this have the benefit of achieving thermal

comfort without the creation of a double skin. And while daylighting conditions must be addressed, the panels could be employed as partitions to deliver thermal comfort and indoor air quality to all spaces within the structure, thus creating a significant reduction in time and cost associated with HVAC retrofitting.

I.4 THE LEAN, GREEN, BUILDING MACHINE

Strategies for Visual comfort, thermal comfort, auditory comfort, energy efficiency and water collection or usage reduction are abundant hot topics in architectural research today and for good reason. Clients demand more from their new building projects than ever before. In transformative architecture, the possible sustainable strategies are unhindered by formal restrictions. In order for these strategies to be effective and well –integrated, they must be investigated in the programming phase. In the UK, Michael Jaggs and John Palmer developed EPIQR: Energy Performance Indoor Quality Retrofit,¹³ which is basically a methodology for building evaluation focused on energy efficiency, improved indoor environmental quality, addition of solar energy and cost effectiveness.

Consider a methodology based on transformative architecture, that augments the EPIQR goals as follows:

1. Potential uses: Understand the client's vision for the building space. Include flexibility in the occupancy types and proposed floor areas for future transformation.
2. Evaluate the structure. If the structure is not the sound, the project needs to be reconsidered because of economic considerations.
3. Consider passive strategies for user comfort. Consider adding a green roof. It not only adds thermal insulation to the roof, it provides occupants with a private park. Make note of solar and wind shadows. Plot overheated periods and consider shading options for the façade. Shading options may be as simple as retractable awnings. Consider rainwater collection and reuse as gray-water systems. Gray-water can be used to flush toilets or irrigate the green roof. Consider adding an insulated layer to the exterior of the building façade to reduce thermal conductivity through the structure. Consider adding a thermal layer to the interior of the façade when asbestos is present and must be isolated or removed. Consider adding an acoustical layer to walls and partitions. Consider improving day-lighting conditions through the size and height of windows, addition of light scoops and reflective shafts for indirect light and adjustable light shelves.
4. Consider active strategies. Chances are that the HVAC system will need to be replaced. The type of HVAC system chosen as replacement will depend on the type of structure and its natural tendency to integrate with the HVAC system. If the building is located on a waterfront, consider the possibility of geothermal using the water source. If the floor plates can hold an additional topper slab, consider radiant floor heating. Consider energy efficient lighting systems with LEDs, occupancy sensors or timers. Consider alternative energy sources such as photovoltaics or wind turbines.
5. Consider acoustical Comfort: Reorganization of space requires thought into the changes in reverberation time and decibel levels that will occur (for better or for worse). Consider if masking will be necessary for occupant privacy.
6. Find unique ways to integrate systems. For example, filter collected rainwater in a wall system that also includes micro-hydroelectric turbines for energy generation and creates white noise for auditory masking. Three needs fulfilled in one system.

I.5 LIVE,WORK AND PLAY

The dynamic vernacular is tightly linked to the life cycle of its neighborhood. Decentralization in cities occurs when neighborhoods no longer function as a place to live, work and play. Thus, it is important to reintroduce mixed use neighborhoods to the shrinking city. An office building does not always need to be an office building. It may become residential units over professional offices

over retail establishments. It may become a vertical university of classrooms, dormitories, cafeterias and studios. The December 2010 issue of *Modern Steel Construction*¹⁰ contains an article about the conversion of the Ottawa Street Power Station in Lansing, Michigan into prime office space. The project involves the construction of a ten story steel frame inside an existing masonry structure¹³. And while this article attests to the possibilities open in transformative architecture, the transformation of a power station to office space only provides a work environment which means that unless it is sitting within a neighborhood of residential, retail and entertainment spaces, it will not help counteract the decentralization of the city.

Successful cities understand the importance of mixed use neighborhoods and in many cases demand development reconcile to the idea. On Capitol Hill in DC, the area around Eighth Street is bustling with restaurants, shops, the Eastern Market, the Navy Yard and even a hardware store. Jenkins Row, a recent addition to the neighborhood located on Pennsylvania Avenue between 13th and 14th streets, contains 247 condo units atop a 45,000sf Harris -Teeter grocery store at street level.

Downtown Cleveland is not without residential units, although amenities such as grocery stores, pharmacies, dry cleaners, hardware stores and other essential shops are rare or non-existent. Most successful mixed use neighborhoods, such as University Circle and the Warehouse District are located in areas where building heights average around three levels. In a typical three story mixed use neighborhood, the pedestrian interface is linear, along the street line. The challenge that downtown Cleveland faces is the height and configuration of its existing structures; tightly built with narrow streets and dark urban canyons. To encourage regrowth, Cleveland should consider alterations to its urban streetscape to allow pedestrians to view more sunlight and vegetation. One method to accomplish this is to step back facades above every third level, creating a local green roof for occupants and reducing the solar shadow at the street level. Stepping back the facades would mean a reduction in rentable floor space, but when a building is vacant and has little chance of becoming fully occupied, the income earned from better quality work and living spaces will compensate for the reduction, if not directly, then by the positive influence it will have on the neighborhood as a whole.

2.0 PUTTING THE PIECES TOGETHER

Transformative Architecture could be a design methodology for shrinking cities. Embracing the idea of the dynamic vernacular allows cities to shed old identities and build new, performative environments. Celebrating open spaces, rather than trying to fill them motivates developers to rethink existing structures. Thinking beyond adding a second skin, to reinventing with new, performative form and use will allow the shrinking city to find itself again.

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Architecture and Landscape of a Mined Environment: Reading the Traces

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ABSTRACT:

This study focuses on the coal company town of Everettville, WV in north-central West Virginia and, at its center, a former mined landscape, Federal No. 3, that is currently being reintegrated into the community as a culture/nature park. The mine began operation in 1921 and a town was established which included hierarchically and racially ordered residences, segregated churches and schools, and a company store. The mine site's significance as a cultural landscape is grounded in an explosion that occurred in the spring of 1927 when 151 miners were killed under suspicious circumstances.

Examining historical maps, photos, and other records of the town and mine site reveals spatial patterns and structures in existence during the area's formative years. Analyzing current conditions through overlay mapping seeks to uncover remnants of the town's form and its current ability to communicate the conditions of the 1920s. LiDAR (Light Detection and Ranging) was used to document current conditions of the mine site: topography, vegetation, spatial organization and architectural forms as a framework for mapping and measuring cultural landscape characteristics and to guide the development of context sensitive interpretive designs.

Overlay mapping depicts substantial landscape change especially related to the development of mine-related infrastructure. While the number of buildings in the town remained relatively constant, new spatial organization was seen especially with evolving infrastructure. The collected point cloud data at the mine site reveals much of the original spatial organization which will guide park development including rail beds and a bench road on which original structures were sited. The point cloud did not however reveal those structures, likely because of re-grading of the site during reclamation and colluvial erosion over time. As the park evolves further documentation will continue to create a four-dimensional model as longitudinal studies examine change over time in landscape forms, patterns and processes.

CONFERENCE THEME: Digital Approaches to the Real World

KEYWORDS: LiDAR, Cultural Landscape Analysis, Interpretive Design, Industrial Landscapes

CONTEXT: SOCIAL, CULTURAL, ENVIRONMENTAL

In cultural landscape analysis and planning, researchers seek to recognize the genesis of places through the lens of human land development over time. While landscapes can be read as text they are also referred to as palimpsests, or multiple texts partially erased written in layers over time. Continuing the metaphor of text, design is often considered 'writing' on the landscape. Cultural landscapes reflect the integration of human developments with the natural environment. They may be interpreted as expressing a particular culture's values, economic conditions, social structure, crafts and traditions.

A cultural landscape is fashioned from a natural landscape by a culture group. Culture is the agent, the natural area is the medium. The cultural landscape the result.
(Sauer 1963, 343)

This study focuses on the coal company town of Everettville a small unincorporated hamlet in north-central West Virginia and, at its center, a twenty-five acre mined landscape, Federal No. 3, that is currently being reintegrated into the community as a culture/nature park. Land for the park was donated by Consol Energy to the Everettville Historical Association (EHA) with the goals of creating a place that tells the multi-layered stories of the community and the mine; and creating partnerships, particularly with West Virginia University (WVU), through educational programs.

The Federal No. 3 mine site is found within the Fairmont Field of the Pittsburgh coal seam, an extraordinarily rich mineral deposit in the Allegheny Plateau physiographic region, a prehistoric carbon rich swampland. Three hundred million years of fluvial erosion cut deep, steep valleys in the plateau revealing the layers of coal. Subsistent settlers mined individually in the 18th century and word spread to corporate interests causing massive development and immigration in the late 19th and early 20th century. The mine is one of hundreds of underground mines with miles of tunnels established in Monongalia County during the period and reflects many typical characteristics of company-owned mines within the region.

The mine site's local, regional and potential national significance as a cultural landscape is grounded in an explosion that occurred in the spring of 1927 when 151 miners were killed during a labor dispute. A spark from an electric locomotive ignited methane gas causing a ball of fire to move through the mine and out at the tippie portal destroying much of the enormous structure. Occurring relatively early in the time of the Northern Mine War (1924-1933) the cause of the explosion was attributed, by divergent parties, to scab workers' mistakes, the union workers sabotage tactics (union barracks were sited across Indian Creek from the mine site), an act of God punishing the scab miners; and the faults of managers not providing enough rock dust to mitigate methane gas accumulation in the tunnels (as was determined by the mine's superintendent). In reference to the tensions in the area this quote from Howard B. Lee, then the Attorney General of West Virginia, spoken after visiting the explosion site in May 1927, describes the rancorous social environment:

It was there that I saw exhibited that snarling animal hatred felt by members of the miners' union for nonunion miners...Apparently, these former workers believed that the explosion was a form of divine punishment meted out to the scab miners who had taken their jobs. And, with a heartlessness akin to savagery, they and their wives would pass nearby and curse and jeer the grief-stricken women and children as they hopefully waited; nor did the death announcement calm their fury or abate their hatred. As bodies were brought to the surface, they sang ribald songs, and frequently used such vile utterances as 'There's another goddamned strikebreakin' scab son-of-a-bitch gone straight to hell'. (Lamarre 1994)

The narratives for interpretation in the site design for the culture park include the social context of Everettville; the establishment and spatial organization of Everettville as an example of a company town; the formal layout of the industrial workings of the mine; and the labor relations that may or may not have been at the heart of the disaster. Historic documents have been accessed to determine the cultural landscape characteristics of the town and mine site and a methodology developed to better understand the town and site's ability to express the narratives.

1.1 TOWN FORM AND CHANGE OVER TIME

Between 1880 and 1930, industrialists transformed West Virginia from a predominately individualistic agrarian mountaineer society, in which centralized towns were not necessary, to an industrial society reshaping its social and cultural landscape. Many company towns were developed haphazardly with the buildings occupying lowlands in hollows along rivers and streams. The pattern of development followed linearly the water course and was limited by very steep topography with most development along floodplain terraces as is the case in Everettville, along Indian Creek a tributary of the Monongahela River. The railroad and road following the river further reinforced the linear character of the town. Towns were racially and economically segregated and a hierarchy was established with the workers occupying low ground in the dust and wetness and noise of the machines and the managers' homes built high above out of the melee.

The company towns were isolated physically because of the locations of the coalfields they sought, so the company provided housing, stores, churches and schools to the workers. (Walker and Cobb, 2008) Company towns were subject to the boom and bust cycle of the coal and timber industries. Because of the economic cycles of the industry the towns were necessarily transient and were considered temporary to developers. Many of the company towns today suffer from neglect and dereliction and may soon be erased from the cultural landscape. These remnants speak to the lowly conditions of the miners and the strict social hierarchy enforced in company towns.

Everettville's basic layout included churches, schools, and a company store. There were separate churches and schools for the purposes of racial segregation, but only one company store. Pick Handle Hill where the Friendship Baptist Church is today was the 'old black section,' with their church dual purposed as the school (Armstead 2001). The housing for the miners was located across Indian Creek adjacent to the tippie. When the mine first went into operation one-story barracks was established until the company grew assured of their investment and more substantial buildings were constructed. The housing for the white mine workers was primarily located at the base of the slope across the creek. Between 1920 and 1927, more than 200 housing units were built as the community of workers increased in number (New England Fuel and Transportation Company, 1927). Many of the homes and other buildings remain from the original construction, and the overall town form, limited by topography, is still intact.

Historical documents accessed for study of the town of Everettville include aerial photos, USGS topographic maps, and photographs; as well as reclamation documents that reveal site conditions post-abandonment; and pre- and post-reclamation. This analysis sets a base line for current studies of the company town. Comparative analysis of aerial photos and maps sought to distinguish between contemporary spatial organization and the period around the time of the explosion. USGS maps from 1925 were digitized and used to document locations of structures, roads, and natural features. The digitized maps were then compared to USGS maps that were created using high resolution digital aerial photos from 2002 in order to determine change over time and the integrity of the town's form. Aerial LiDAR data will further determine integrity of the town's spatial organization.

Change observed from 1925 to 2002 was quite dramatic. The number of structures in 1925 (95) is similar to the number of structures in 2002 (99), however, many of the 1925 structures had been removed with new structures added. Road alignments also shifted with additions to highway infrastructure over time. The Indian Creek and Northern Railroad connecting Federal No.3 to the Monongahela Railroad and points north was abandoned. New roadway alignments took the place of the abandoned Indian Creek and Northern routes and included traveled way widening and sub base reconstruction. With this abandonment and transition to a new roadway many of the structures and buildings associated with the railroad were removed. A new area for collecting mine drainage was also added post 1925 as an embayment, dramatically shifting the course of Indian Creek as it entered the Monongahela River. In residential areas some new subdivisions were added as extensions to the existing roadways.



Figure 1: This image shows the structures (white) mapped in the 1924 USGS map and those extant in 2002 (black). Many contemporary structures relate to 1924 locations though they are shifted because of inaccuracies in the 1924 survey.

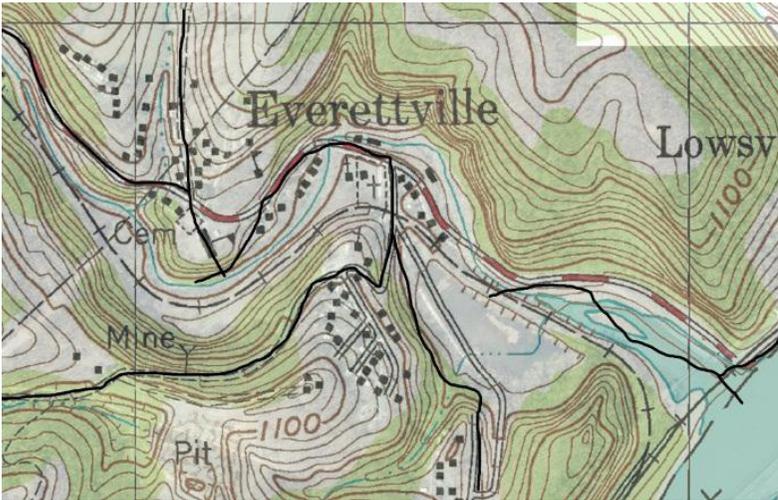


Figure 2: The black line is the 1924 roads layer. Shifts in infrastructure in Everettville occurred after 1924 with expanded development of mining along Indian Creek.

1.2 MINE SITE SPATIAL ANALYSIS AND CHANGE OVER TIME

The area now known as Everettville Miners Memorial Park was once designated as the Everettville Refuse and Portals (WVDEP) and was previously known as the Federal No. 3 Mine, a facility originally owned and operated by the New England Fuel and Transportation Company (NEFTCo). The Everettville mine began operation in 1919. During the functioning of the mining operations the entire twenty-five acres was transformed purely for industrial uses. It is known from historic photographs that the spatial organization of the district consisted of typical mining constructions: rail line and tippie as transportation infrastructure, a hydrologic installation accessing a nearby stream, company offices and housing. While many of these elements of the district have been substantially erased over time, some are still legible and may guide future site interventions. Other evidence suggests that the footings of the tippie structure are extant below ground and could provide an important interpretive opportunity.

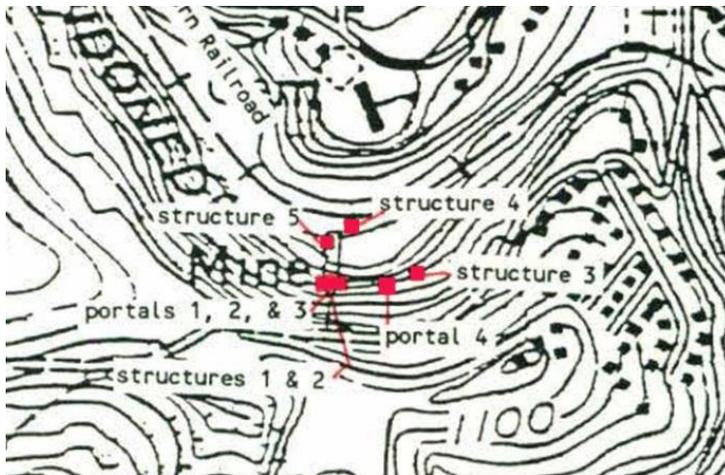


Figure 3: The survey performed by the WVDEP and WV Survey Archeologist shows the locations of mine related structures on the mine site as observed in 1994.



Figure 4: A panoramic photograph of the mine site taken December 31st 2010 showing the LiDAR unit and existing site conditions.

Descriptive data was collected from aerial photographs, site plans and maps (USGS Rivesville Quad), oral histories and historic photographs from the time of the mine's operation from. The pre-reclamation report (WVDEP) guided the search for specific forms in the landscape. Forms that were identified in a survey by a WV Survey Archeologist (Lamarre) in 1994 are described in the environmental review documents pre-reclamation. Lamarre describes the scene approximately forty three years after mining was stopped in 1951.

This area is in ruins; briars and secondary growth forest have overrun the decaying facilities, and all of the remaining structures are in some state of collapse. The Indian Creek and Northern Railroad grade is still intact, but the track has been removed, and ties are scattered everywhere...and, of course, the original wood tipple, which was at least partially destroyed in the 1927 explosion, no longer exists. Of the five structures identified during the field visit, only two appear to date from the original operation. Structure 1. The remains of a cut stone foundation, believed to be a part of the original facilities, are located just outside and to the east of portal 1. The stones are covered with a thick layer of colluvial soil deposits, moss and other vegetation, and appear to abut the original mine face-up. It is possible that this foundation contained the fan house, and that, through portal 1, provided ventilation for the mine. Structure 2. A second foundation is situated between portals 2 and 3. This one is constructed of glazed clay hollow tiles, and like the first foundation, seems to adjoin the original mine face-up. It is also believed to date to the years of NEFTCo's operation, and may be the site of the original lamp house. (Lamarre 1994)

A bench approximately sixty feet above the road running east to west from Friendship Baptist Church along the south ridge of the site ordered the original structures and portals mentioned in the archeologist's report. Walking today the road is legible though landslides and dumping from Pickhandle Road have covered much of the alignment. A large slide nearing the portals has decimated the roadway. None of the footings are visible though the portals are clearly distinguished. One of the portals' facades, Portal #3, still bears the inscription 'Federal No. 3 Mine'. In descriptions of the 1927 explosion, the blast was reported as coming from the middle portal, number 2.

LiDAR (Light Detection and Ranging) technology was applied to the documentation of topography, vegetation, social usage patterns and architectural forms as a framework for mapping and measuring cultural landscape characteristics of the mine site and to guide the development of context sensitive interpretive design proposals. The LiDAR unit uses laser pulses and time of flight of the laser to create a highly accurate digital three-dimensional model of the scanned space. The resulting point cloud may then be geo-referenced and used in landscape analysis. Additionally, the point cloud may be photo-realistically rendered in order to provide an environment for design visualization.

Data was collected in early winter in a leaf-off vegetation condition. Snow was minimal and many of the grasses were prostrate. Because the instrument used is ground-based obstructions to the documentation of landform by vegetation were avoided to the extent possible. With the accuracy of the three-dimensional model the discovery and revelation of former structures and spatial patterns within the study area became possible (Gleason 2010 and Harmon, et al 2006). The model

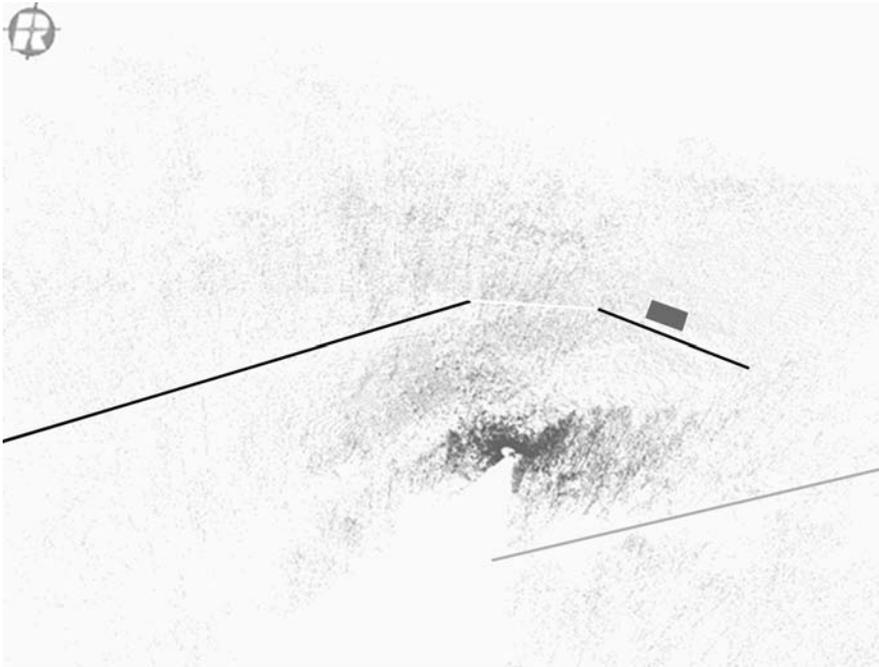


Figure 5: Point cloud image of Everettville mine site. The bench road on which mine structures were formerly sited is marked by a black line. The area marked by a white line is where colluvial erosion has covered the bench road. The gray line shows the rail bed of the Indian Creek and Northern Railroad. The gray square depicts the location of Portal #3. The circle at the center of the image is the location of the LiDAR instrument.

allowed for automatic analysis of collected point cloud data. The identification and documentation of structures was partially achieved through programmed recognition of line, pattern and form. Automatic analysis using processing software (Riegl RiProfile v1.5.5) revealed patterns within the landform that could not be read with the naked eye during site visits. Identification of slope break lines, subtle shifts in topography and colluvial erosion, vegetative anomalies, and former building site footings and walls within a contoured landscape became visible and interpreted through trained eye analysis. Point cloud data was analyzed with different view types: amplitude (linear scaled and histogram), reflectance (linear scaled), false color (range, height, and plane), true color (linear scaled and logarithmic scaled), and single color. The view parameters assisted in distinguishing spatial relationships in the point cloud and allowed for the discrimination of different forms.

1.3 CULTURAL LANDSCAPE ANALYSIS AND PLANNING

Spatial Organization and Land Patterns: The alignment of Indian Creek created the overall spatial organization of Everettville and the mine site. Many of the structures that lined the creek during the heaviest industrial use periods are now gone and have been replaced primarily with prebuild homes. The constraints of surrounding topography restrict development within the former spatial pattern. This will remain constant over time. Mining operations followed the flow of Indian Creek on a west to east tangent. The landform created by the flow of the river follows directionally sweeping towards the Monongahela River. The mine site in particular still maintains gross spatial organization from the 1920s. The main rail bed of the Indian Creek and Northern Railroad is still legible, as well as the spur that led to the Federal No. 3 tipple. The bench road is still partially traversable, though sections have been obliterated over time.

The mine site's topography was impacted by the reclamation process in the 1990s. The removal of debris and shifting of gob piles obliterated much of the cultural forms built into the operations of the site. The re-grading of the site did not change the major topographic components: the rail beds and bench road. Hundreds of yards of soil were laid over the mine waste to encourage the growth of seeded grasses. Contemporary illicit dumping on the site pre and post-reclamation has left new topographic forms within the boundaries of the site.

As was common practice in the early 20th century, the site of the mine was clear cut of vegetation. Only one remnant tree that may date back to the time of the mining operations remains on the site. A single massive Sycamore (*Platanus occidentalis*) stands opposite the mine Portal #3 as a witness to the years of industrial development and the explosion of April 30, 1927. Its exact location was recorded with the LiDAR data and will be a component of the interpretation of the site.

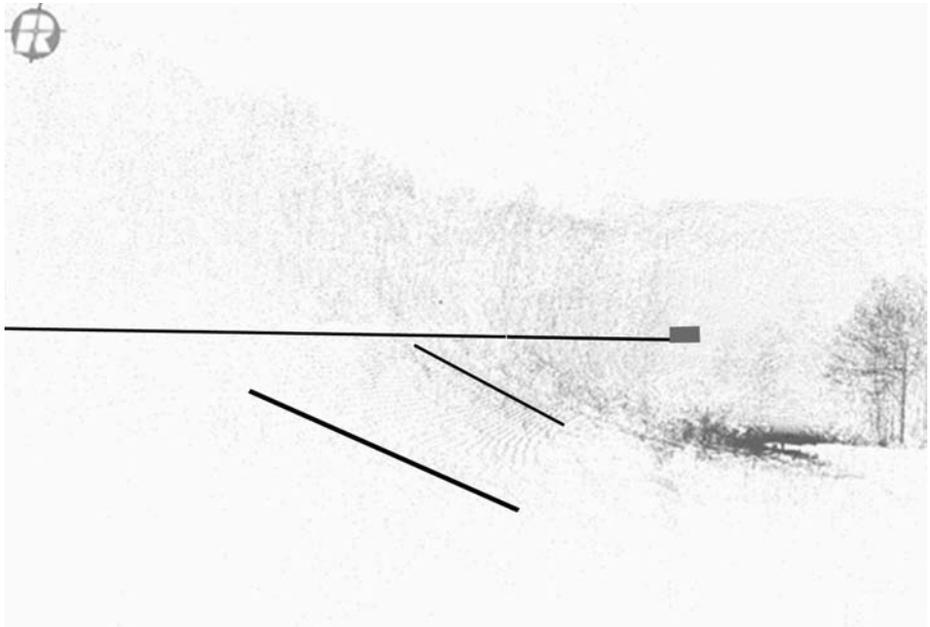


Figure 6: Point cloud image showing drainage swales (diagonals) and bench road (horizontal) with Portal #3 as viewed from the east.

The circulation patterns of the railroad, bench road, and the access bridge crossing Indian Creek with remnant cut limestone footings are suitable for interpretation and will become components of future pedestrian circulation routes. The theme of 'paths to work' has been determined to be a guiding concept in the culture/nature park development. The circulation patterns are also ingrained with the racial segregation narrative of site interpretation. Connecting a trail along the rail corridor to the Monongahela River along the embayment drainage pond is also a key component to the future park.

While there are no standing structures on the site their locations will be determined. With the uncovering of foundations, the identification of the tipple footings and the facades remaining at the portals, structural elements will be a component of future plans. The concise alignment of the tipple will guide development as well as it creates a strong connection between the slope of the valley wall and the creek. A remnant tipple footing has been found on the site and will be used for interpretation. Walls of the original structures when uncovered will become mnemonic devices along the bench road path. And as site surveying continues in the coming years uncovered objects will be collected for interpretation.

CONCLUSIONS

The cultural landscape analysis of the town of Everettville shows extensive change in the spatial organization and structure layout over time. The change seen after 1924 with the development of the mine and subsequent water, road and rail infrastructure may be suitable for interpretation though further research is needed. The analysis of existing conditions at the mine site reveals much of the former spatial organization especially in regards to the bench road and the rail beds. These patterns, though degraded, are legible and would be suitable for a newly introduced spatial organization in the development of a culture park. The use of the LiDAR data in documenting and analyzing existing conditions reveals the former patterns and further excavations or explorations may disclose building locations along the bench road, specifically the lamp house and vent house, though they were not observed in the point cloud. With an uncovering of the slumped area of the bench road these forms would likely be exposed.

Programmatically, the community of Everettville, with a lack of a community core public space for recreation as a result of the 'company town' development, is in the process of planning and constructing a community focused memorial park on the historic site. While many of the elements of the district have been substantially erased over time, some are still legible and will guide future site interventions. The rehabilitation, or supporting of new uses, and interpretation of the significant elements of the site create challenges in envisioning its future development.

As the culture/nature park is developed the three-dimensional digital model will become four-dimensional as longitudinal studies examine change over time (Burnett 2003) in landscape forms, patterns and processes. Restoration of ecological communities, mitigation of acid mine drainage, and physical responses to periodic flooding will be observed to track the evolution of the relationship between extant and introduced natural and cultural systems in the development in the park. As the park becomes integrated with the community, programmatic interrelationships between pre-development subversive site uses and post-park establishment activities may be measured as site/community interaction (Ward Thompson, Aspinall and Bell 2010) and response to landscape interventions.

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Nelson Goodman's philosophy: an analytical account of architecture

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ABSTRACT:

Architects resort to philosophy to get inspiration for their projects and to interpret their work. While mainly philosophical currents belonging to the continental tradition have made important contributions to architectural theory, the Anglo-American or analytical tradition is generally not considered. This paper presents the thought of American philosopher Nelson Goodman (1906-1998) as a fruitful alternative to continental accounts of architecture. Goodman's approach to architecture provides new insights to understanding and interpreting the built environment, and his philosophy serves as an example of analytical thinking on architecture that complements the variety of reasoning already at hand for architects.

Following Goodman, architecture plays a key role in the creation of meaning and reality. First, architecture creates meaning and contributes to the advancement of our understanding in a unique manner: buildings are symbols, they mean in various ways, and these meanings are irreducible to other kinds of knowledge. Second, architecture contributes to the making of the world in a radical sense: not only in that buildings are physical objects and, as such, constitutive elements of our world, but in that their various meanings have an ontological counterpart. That is to say, it is not the case that there is one world and many interpretations of it, but rather that these various interpretations and meanings actually constitute different worlds. Given this interrelation with meaning and reality and architecture's central role in both, the task of the architect acquires a wider significance, for designing entails the very creation of meaning as well as of our world.

This paper aims to show how both Goodman's thought and the concepts and methods characteristic of analytical philosophy are helpful conceptual tools to examine buildings. Simultaneously, it shows how analytical philosophy can enhance the architect's critical skills when designing and thinking about architecture.

CONFERENCE THEME: On Approaches. The role and use of philosophy in architectural research.

KEYWORDS: analytical philosophy, Nelson Goodman, symbol, worldmaking, understanding.

INTRODUCTION

It is not uncommon that architects and architecture students resort to philosophical theories, notions, and ideas to both get inspiration for their projects as well as to look for explanations to their work. So, phenomenology, structuralism, post-structuralism, and critical theory have made important contributions to architectural thought and have served as basis for contemporary architectural theory and practice. These philosophical currents, however, belong mainly to the continental tradition, while the Anglo-American or analytical tradition is generally not considered. This paper presents the thought of American philosopher Nelson Goodman as a fruitful alternative to continental accounts of architecture. On the one hand, Goodman's approach to architecture provides new insights to understanding and interpreting the built environment. On the other, Goodman's philosophy serves as an example of analytical thinking on architecture that complements the variety of reasoning already at hand for architects.

Nelson Goodman (1906-1998) was one of the foremost analytical thinkers of the twentieth century, with groundbreaking contributions in the fields of logic, philosophy of science, epistemology, and aesthetics. Goodman specifically discussed architecture in his main work on aesthetics, *The Languages of Art. An Approach to a Theory of Symbols* (1968), and in two essays entitled "How Buildings Mean" (1985), and "On Capturing Cities" (1991). Moreover, his main philosophical notions and theses apply as well to architecture and, as this paper argues, may provide novel insights to both the making of and the thinking about architecture.

Following Goodman, architecture plays a key role both in the creation of meaning and reality. On the one hand, architecture creates meaning and contributes to the advancement of our understanding in a unique manner: buildings are symbols, they mean in various ways, and these meanings are irreducible to other kinds of knowledge. What we learn of space, the building's features, and ourselves when experiencing architecture, for example, cannot be completely translated into words. Buildings, thus, enhance our understanding in an irreplaceable way. On the other hand, architecture contributes to the making of the world in a radical sense: not only in that buildings are physical objects and, as such, constitutive elements of our world, but in that their various meanings have an ontological counterpart. That is to say, it is not the case that there is one world and many interpretations of it, but rather that these various interpretations and meanings actually constitute different worlds. Given this interrelation with meaning and reality and architecture's central role in both, the task of the architect acquires a wider significance, for designing entails the very creation of meaning as well as of our world.

The purpose of this paper is thus to show how both Goodman's thought and, in general, the methods, the concepts, and the ways of arguing characteristic of analytical philosophy are helpful conceptual tools to examine buildings in a novel and fruitful way. At the same time, I hope to show how analytical philosophy can enhance the architect's critical skills when designing and thinking about architecture. The first part of this paper provides the philosophical context to understand what it means that buildings are symbols and what the consequences of such statement are. The second part examines the several ways by which buildings symbolize and convey meaning. The third part examines the ontological counterpart of considering that buildings function symbolically, i.e., it shows how buildings are, as Goodman says, ways of worldmaking.

I. A CHANGE OF QUESTION: WHEN IS ARCHITECTURE?

Buildings have a practical function of sheltering human activities. In addition to this, they convey meaning: palaces, parliaments, and city halls refer to certain political systems; temples, churches, synagogues, and mosques stand for different religions; museums, hospitals, jails, schools, and universities refer to cultural and social structures; factories, warehouses, markets, banks, and malls point to certain economic systems; apartments, housing tracts, townhouses, mansions, huts, and tents reflect various ways of life. Apart from these social, cultural, and historical meanings, we appreciate the artistic features of buildings - such as the qualities of the materials, their forms, or their creation of spaces, we judge and evaluate them, and we also learn about ourselves when interacting with them. How is it possible that one and the same building can be considered simply as a building that we use in everyday life, as a construction with social or historical meaning, and also as a work of architecture or art that we experience aesthetically? How can a building carry out all these functions without changing?

The answer is that buildings can have various meanings and can function in different ways because they are objects that can also be symbols. In this way it can be explained how one and the same building can sometimes be considered simply according to its functional use (and then it is not a symbol at all), sometimes as conveying any kind of meaning or sometimes as suitable of being aesthetically appreciated. Saltbox houses, the earliest New England homes, have a primary function of providing shelter, and now they are also considered artistic examples of American colonial architecture. So, when a construction is considered as art, it is architecture; otherwise, it is simply a building. This means that the status of art or architecture does not need to be permanent and, therefore, it makes no sense to search for an essence that would distinguish simple buildings from architecture, for one and the same building can function as both. When a church is used as a place of prayer and worship, it is just a building; when its construction features are appreciated, it is architecture. Thus, it is inappropriate to ask "*What is architecture?*" Rather, according to Goodman, one should ask "*When is architecture?*" In his words:

Part of the trouble lies in asking the wrong question – in failing to recognize that a thing may function as a work of art at some time and not at others. In crucial cases, the real question is not "What objects are (permanently) works of art?" but "When is an object a work of art?" – or more briefly, as in my title, "When is art?" (Goodman 1978, 66-67)

This change in focus entails an understanding not of what architecture is, but rather of when a work of architecture functions as such. Goodman's answer is a pragmatic one: architecture is when a building functions as a symbol of a certain type. This approach that derives from the shifting from "what" to "when" is not simply a word game: it enables a completely different approach to architecture that abandons an essentialist take of architecture in favor of a much broader and elastic characterization, which for Goodman is a constructivist and functional one. By changing the approach, the essentialist, intentionalist, and institutionalist accounts on architecture are rejected and the difficulties they pose are solved.¹

According to essentialism, there are some necessary properties that characterize what architecture is. To be considered architecture, an object has to comply with these essential features. However, it is very difficult to determine what these properties are, as can be seen when trying to establish a definition that would include all actual and future architectural works. Consider the definition of architecture in the *Oxford English Dictionary* (OED) as "[t]he art or science of building or constructing edifices of any kind for human use" (Anon. 2007). Contrasting this specific definition with our current use of the term "architecture," one realizes that this definition is either too limiting or too broad: it excludes, for instance, landscape architecture, and also all buildings not intended "for human use," such as poultry yards, pigsties, silos, and warehouses. The OED definition is too broad because it overlooks the distinction usually made between some constructions that are architecture and others that are simply buildings: we consider that the Taj Mahal is a work of architecture but the apartment building where I live is not. We could try to amend the initial definition by extending and refining it, as is actually done in the OED: "But architecture is sometimes regarded solely as a fine art" (Anon. 2007). In that way, the difference between simple buildings and works of architecture is acknowledged, but the problem of finding an exact definition is not solved. Rather, it is deferred towards finding an exact definition of the other terms of the definition, such as "fine art." One could continue rewriting this definition until it could seem that it covers all the cases. However hard we would try, though, there could always be a case that obliges us to modify the definition and the undertaking of giving a definition becomes a Sisyphean task. Moreover, essentialism cannot explain how it is possible that buildings sometimes function as architecture and sometimes not: New England salt-box houses are simply shelters and also examples of Colonial architecture and it is not the case that saltbox houses become works of architecture and thus gain an essential feature they did not have before, which causes a change in their meaning, or that we recognize that they had always been architectural works and we had been misconceiving them. Essentialism cannot account, either, for cases that are temporarily, and not permanently, works of architecture.

According to intentionalism, something is architecture if its creator intended to create an architectural work. There are various reasons to reject intentionalism. First, it is not always possible to know the artist's intentions, as happens with anonymous works, such as the Romanesque Churches at the Vall de Boi in the Pyrenees. Second, an architectural work may be the result of unintended actions, which have nothing to do with the creator's intentions, such as the Crystal Palace, where Paxton used iron trusses in order to sustain the glass roof but without the intention of producing and artistic outcome. And third, not all the works are successful, i.e., what the artist intended is not always accomplished by the work and thus the architect's intentions are irrelevant when determining whether a building is architecture because the intentions do not come through.

Finally, the institutional account states that the work's institutional context (the "artworld") establishes what counts as an architectural work. Institutionalization, however, is neither necessary – a work can be architecture independently from its context, nor sufficient – an object can be conferred the status of architectural work and still not be one. The aesthetic functioning of the house on top of the street is unnoticed by the artworld, and yet the house still functions as an artistic symbol and thus is architecture – institutional theories are not necessary. The umpteenth bridge by Calatrava, identical to several of his previous bridges, even though conferred the status of a work of art or architecture by the artworld, does not function as such – institutional theories are not sufficient.

Goodman's account overcomes all these difficulties by stating that a building is architecture when it functions as a symbol with certain characteristics: when it functions as an aesthetic symbol. Thus, the answer to "when is architecture?" is:

[...] just as an object may be a symbol [...] at certain times and under certain circumstances and not at others, so an object may be a work of art at some times and not at others. Indeed, just by virtue of functioning as a symbol in a certain way does an object become, while so functioning, a work of art. (Goodman 1978, 67)

This is clearly a pluralist and functionalist approach, for the same object can function in many ways depending on the symbolic context; it entails also that everything can be aesthetically perceived, that any building can potentially be architecture. Through interpretation we distinguish what functions as architecture, and we also determine what and how a building means. It is not the case that there is only one right interpretation, but rather a symbol is open to several equally right interpretations (Goodman, Elgin 1988). Utzon's Sydney Opera House, for example, can be interpreted as symbolizing a group of sails, a cluster of shells, old men's messy hair or even the hair of the manga series *Dragon Ball*, Son Goku, when adopting the "super sayan form." But it would be very difficult to argue that the Sydney Opera House refers to a tomato. There are criteria to distinguish between right and wrong interpretations, such as coherency and consistency with the symbol's features and also with its context. These criteria are crucial inasmuch as the several construals are also constructions of the world (as is discussed in the last section) (Goodman 1978). Within this context, the task of the architect is more one of creating meanings and enabling interpretations rather than simply one of constructing functional spaces. The architect is then a symbol maker.

So, if the role of the architect is to create meanings, then it is clear why the main role of architectural works is cognitive and why aesthetics is a branch of epistemology (Goodman 1978). Architecture contributes to the advancement of understanding in a unique way, which is as valid as the one conveyed by any other discipline, such as sciences or the humanities. Architecture, for example, can spatially convey the notion of proportion, whereas music does it in an acoustic way and mathematics in an arithmetical one. These three ways of conveying meaning are irreducible to one another; something would be lost in translation. Understanding, then, is not limited to propositional knowledge, but is a much broader notion that includes all sorts of beliefs, opinions, emotions, and experiences. Within this context, buildings convey meaning by symbolizing.

2. BUILDINGS AS SYMBOLS

Buildings are symbols when they refer to or stand for something else (Goodman 1984).² As the previous examples show, buildings do not limit themselves to refer to a single meaning but can stand for many things. As symbols, they require interpretation to determine what they refer to at a certain time and context. This is so because buildings and, in general, all symbols, do not function in an isolated way, but within symbol systems with specific features.³ To understand what they mean or symbolize, one needs to interpret them in relation to the system to which they belong. Take, for example, a traffic light, which is a symbol within a basic symbol system: Green symbolizes "go" and red "stop," as established by the system's features. But green can also refer to "envy" and red to "embarrassment" within a system that associates colors with moods. We need to know the system to interpret these colors properly. The same happens with buildings: They may belong to one or more symbol systems, which are generally more complex than the color systems just discussed. So, Frank Gehry's Stata Center at the Massachusetts Institute of Technology symbolizes an academic building within a system that classifies buildings according to the activities they shelter; it symbolizes a green building within a system that categorizes environmentally friendly buildings; and within artistic symbol systems it refers to certain forms, materials, an architectural style, and many more abstract features, such as creativity and exploding ideas.

Within a symbol system, buildings (and symbols in general) refer in various ways or modes. With relatively few modes, all possible meanings can be conveyed. Denotation and exemplification are the main ones. The other modes - expression and indirect modes of reference - are combinations of these two. Denotation is the relation between a label and what it labels, and these labels do not need to be verbal: the word "house," its utterance and a picture of a house denote a house (Goodman 1968, Goodman 1984). There are relatively few cases of buildings that denote, the most common being buildings representing other buildings, i.e., copies and reproductions (such as the Parthenon in Nashville and the various Eiffel Towers spread around the world), and buildings representing certain

objects (for example, the Sydney Opera House depicting a group of sails, and buildings depicting the food sold within them, such as donuts or apples).

On the other hand, exemplification runs in the opposite direction of denotation, from what is denoted to that which denotes. An exemplifying symbol requires possession plus reference (Goodman 1968) and referring to only some of the properties that it actually possesses, but not to all of them - exemplification is selective (Goodman 1978). A model house usually exemplifies the number of bedrooms and bathrooms, the house's distribution, the size, and the construction materials, but not its placement, accessories, or wall color. Buildings may exemplify any of the properties they possess, depending on the symbol system to which belong. They may exemplify form (roofs exemplify triangles, pyramids and obelisks their respective forms, and high-rise buildings verticality), structure (like the John Hancock Tower in Chicago or the Eiffel Tower), construction elements (like the Centre Pompidou in Paris, which exemplifies the mechanical systems), materials (wood, iron, glass, steel, brick, stone, and their corresponding properties are exemplified by many buildings) and function (buildings representing ice cream, hot dogs, burgers, donuts, clam boxes, or milk bottles usually exemplify their function of selling these foods; here, exemplification is achieved through a prior denotation of these objects).

One architectural way of making these features stand out and facilitate exemplification is articulation, which can be defined as some sort of joint that structures design elements in a construction (Ching 1995). The purpose of articulation is to bring together the several parts of a building into a whole and, at the same time, make each of these parts stand out. In the Hancock Tower, for example, the structure is articulated by being placed in the building's exterior and covered with a cladding so that it stands out in contrast with the glass walls. This articulation further enables exemplification of the structure. However, although articulation may contribute to exemplification, it is neither necessary nor sufficient for symbolizing. Many exemplified features (such as being an academic building or being an original or groundbreaking one) do not require articulation, and, on the other hand, the mere presence of articulation does not assure exemplification (the emergency exits of a building are clearly articulated, but not commonly referred to by the building). It is important to note, though, that through articulation the architect can prompt a certain kind of symbolization and thus create meaning.

Denotation and exemplification can be both literal and metaphorical. In a metaphorical manner, Goodman describes metaphor as "a matter of teaching an old word new tricks" (Goodman 1968, 69) and includes many varieties, such as hyperbole, understatement, overstatement, or irony. Crucial to Goodman's account is that metaphors are not just figures of speech, but they are actual properties. Like literal properties, they are really possessed by the symbol and thus can be exemplified (Goodman 1968). So, the Stata Center metaphorically exemplifies being a green building, for it is environmentally friendly, but it does not literally exemplify being green, because it is not that color. This distinction is central to understand how the sentence "The Stata Center is a green building" is simultaneously true and false: it is true if green is a metaphorical property, and false if it is a literal one. When metaphorical exemplification occurs within aesthetic systems, it is termed expression (Goodman 1968). As architectural works, the Stata Center may express exploding ideas, the Hancock Tower an imposing presence, and a bank security and stability.

Apart from these modes of reference, there are multiple and indirect ways of symbolizing, such as allusion, variation, and style, which can be explained through a combination of the simple modes of reference with more or less complex chains of reference. A building alludes to another when it refers to it at a distance: the Pantheon in Paris alludes to the one in Rome (Goodman 1984, Goodman Elgin 1988, Elgin 1983). Variation upon a theme is a typical mode of reference in music and consists of referring to another piece (a theme) by symbolizing certain features of the piece while altering others (Goodman, Elgin 1988). Again, the Pantheon in Paris may be considered a variation of the one in Rome. Style is a mode of reference composed a series of symbolized properties which all together refer to a certain author, school, period, region, etc. (Goodman 1978). A church, for example, may symbolize Romanesque style. Determining what mode of reference is in play when symbolizing is a matter of interpretation. Just as there where many possible correct interpretations of a building's meaning, there are also many possible correct ways of explaining how these meanings are symbolized.

These are the ways in which buildings convey meaning. The architect can utilize architectural means to achieve certain symbolization and create meanings. The architect, however, is not only a symbol maker, but also a world maker in a radical sense.

3. BUILDINGS AS WAYS OF WORLDMAKING

As said, buildings contribute in the creation of meaning. They also contribute to the making of the world, not only in a physical sense, but in an ontological one. Buildings symbolize different things in various ways within a plurality of symbol systems, which are irreducible to one another and lack a last referent that would serve as a common ground. That is to say, there is not “a” world or “the” world prior to all meaning, but only a plurality of symbol systems, which are the ones that actually constitute our reality (Goodman 1978). This conclusion is extracted from the analysis that Goodman makes on contradictory propositions impossible to eliminate, such as the incompatible propositions regarding the sun according to the geocentric and the heliocentric systems: the sun is a star moving around the earth according to the geocentric system, and a star around which the earth moves according to the heliocentric system. Both systems have different notion of sun, and thus there is not a last referent that would accommodate both. One could say that it is known that the geocentric system is wrong and hence there is still a single referent to contrast our propositions. But the geocentric system is not as easy to dismiss as it may seem: we usually say that “the sun rises in the East” or that “the sun sets in the West,” which entails to acknowledge a geocentric system. That is to say, since there is a plurality of systems or world versions that may create incompatible worlds, there is not only one way in which things really are. Take another example: light can either be understood as a wave or as a particle, and these two interpretations actually create two different worlds with different criteria of rightness and adequacy. These world versions are irreducible to each other; it is impossible to have a world in which light is considered as a wave and as a particle simultaneously. This means that there is not a ready-made world from which we extract immutable facts: worlds and their components are made (Goodman 1978). And any discipline that contributes to the advancement of understanding by creating symbol systems, such as architecture, is also contributing to the creation of a world, i.e., the ways of creating meaning are also ways of worldmaking.

Note, however, that it is not possible to create from nothing; to make a world is always and only to remake it. Worldmaking is similar to language; we cannot create a new language from nothing, but from an already existing one. We can introduce new words to designate new insights, but this creation takes place within a language. Or, more generally, worldmaking does not start from nothing or from a given immutable world in the same way in which we do not start understanding things from scratch, but from a series of previous beliefs and conceptions. Also, worldmaking is a never-ending and open-ended process, for a version or an interpretation of the world is always susceptible of being modified. Since construing a world is always and also constructing a world, the criteria to consider that a world is right are the same as the ones that serve to consider that an interpretation is right. It is not the case that anything goes, but there are criteria, such as rightness, adequacy, coherency and consistency that determine what interpretations and versions are acceptable (Goodman, Elgin 1988).

Rightness is a very general notion that includes not only truth, which is limited to declarative propositions, but also “standards of acceptability that sometimes supplement or even compete with truth where it applies, or replace truth for nondeclarative renderings” (Goodman 1978, 109-110). Works of art and architecture are not true or false, as are propositions or mathematical formulas, but rather their symbolization is fair or unfair, right or wrong depending on how they symbolize within a given context. Affirming that the criterion of rightness of an interpretation is the symbol itself and that there can be multiple correct interpretations of the same work implies that there are no external reasons to privilege certain interpreters above others. In other words, the social, historical, or cultural causes that prompted certain interpretations are in themselves irrelevant for establishing the rightness of each interpretation: feminist or postcolonial interpretations of a work are not right or wrong because they are feminist or postcolonial, nor superior or inferior to others because they have a certain origin; being interpretations of a certain kind does not invalidate or validate them. Rather, some interpretations are adequate to a work – and thus privileged – and others are not based on the work’s symbolic functioning. Note also, that to affirm that a work of requires interpretation implies

also that it can always be misinterpreted. However, misinterpretations can be disregarded as soon as they are contrasted with the work's functioning as symbol. Hence, Goodman opens the possibility of a plurality of different but equally right interpretations of a work, which are independent of the context or concerns that prompted these interpretations and, thus, also independent of arguments based on the interpreter's authority and the institutional context. This means that the creation of interpretations and unveiling of meanings (and also further creations of world-versions) can be historical, social or cultural, but the reasons to maintain that an interpretation is right are not. This is what Goodman calls a "constructive relativism," which is an intermediate position between radical absolutism – where only one interpretation is correct – and absolute relativism – where anything goes (Goodman, Elgin 1988).

Interpretation is then a matter of fit, "of some sort of good fit – fit of the parts together and of the whole to context and background" [Goodman, Elgin 1988, 46].

Thus, architectural works and the several interpretations they bear as symbols actually contribute to the advancement of understanding and also to the creation of world-versions. Architecture can provide new insights in a way that no other discipline can provide and, in so doing, create unique versions of the world that, in their turn, can influence other versions. By modeling space, light, and construction materials, buildings can create environments that can make us aware of previously unnoticed features. The central nave of some Renaissance churches create a perspectival space that, once experienced, may enable us to see the space outside the church in a perspectival centered way; Baroque churches create dynamic spaces that, once experienced, can bring us to perceive space in a different way than the Renaissance churches. By symbolizing features such as proportion, rhythm, symmetry, or massiveness in a unique way the meaning of these notions is enhanced, nuanced, or shifted. By symbolizing in several different ways, architecture can reshape our perception and reorganize our understanding of the several worlds (if any) that constitute reality. In this context, architects are worldmakers in a fundamental sense.

CONCLUSION

Goodman's philosophy offers a new insight into architecture and its significance or, in other words, it provides a philosophical framework to understand how we create and interpret both architectural knowledge and architectural works. By changing the question of "what is architecture?" to "when is architecture?" and by answering that buildings are symbols, a whole new way of inquiry and thinking about architecture is opened. We enter a functionalist and pragmatist realm that has criteria of consistency and coherency that simultaneously preclude a total absolutism and a total relativism of meanings and worlds. With relatively few modes of symbolization, all the array of a building's meanings is accounted for. Most importantly, by considering that architects are not simply object makers but also symbol makers as well as worldmakers, architecture acquires both an epistemological and an ontological dimension that had not been considered before. Furthermore, not only architects but also the general audience or the building's users become interpreters that play a key role in creating and unveiling the multiple meanings of architecture. At the same time, examining architecture under the light of Goodman's thought shows how analytical philosophy can help in the continuous process of construing and constructing buildings, as well as of understanding how architecture contributes to the making of meaning and reality.

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ENDNOTES

¹ For more information on essentialism, intentionalism, and institutionalism in the arts see, for instance, Danto 1964; Detlefsen, McCarty, Bacon 1998; Dickie 1977, Dickie 1984, Kieran 2006, Yanal, 1998.

² Goodman explains, "Reference' as I use it is a very general and primitive term, covering all sorts of symbolization, all cases of standing for." Goodman 1984, 55.

³ Goodman's theory of symbols is much more complex than what is discussed here. For a thorough discussion see Goodman 1968, and Elgin 1983.

Project Nervi: Aesthetics and Technology

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ABSTRACT:

Project Nervi: Aesthetics and Technology in Building Pier Luigi Nervi questioned the nature and physical impact of the relationship between aesthetics and technology from the viewpoint of architecture, engineering and construction; this question remains vital for both academy and profession. Project Nervi, a collaboration of the CMU School of Architecture and the Carnegie Museum of Natural History, was formed to extend the engineers proposition of the relationship of aesthetics and technology by undertaking an empiric research project to characterize the relationship between material placement and aesthetics in architecture with reference to the correlation of material placement and performance found in nature. The tools of Processing and Grasshopper combined with physical modelling are used to better understand Nervi's structural/visual thinking of the cast concrete floor plates at the Palace of Labour (1961), the Gatti Wool Factory (1951) and the Palazzetto dello Sport (1957) and to morphologically further these prospects. In the second part of this study, we apply the pattern research to two relatively new building materials, plywood and carbon fiber for lightweight stressed skin construction based on force trajectories.

KEYWORDS: Nervi, pattern, structure, nature

"The form [...] of any portion of matter, whether it be living or dead, and the changes of form which are apparent in its movements and in its growth, may in all cases alike be described as due to the action of force. In short, the form of an object is a 'diagram of forces' in this sense, at least, that from it we can judge or deduce the forces that are acting or have acted upon it."

D'Arcy Wentworth Thompson, On Growth and Form

1.0 INTRODUCTION_PATTERN RECOGNITION AND KNOWLEDGE TRANSFER ACROSS FIELDS

Structural patterning is of significant interest to many fields, including chemistry, biology, materials science, medicine, engineering and architecture. The deeper we look, the more we find that geometric arrangement is responsible for chemical and material properties and our sensorial perception of their qualities. This condition operates at a range of scales and forms the base inquiry of nanotechnology, the orchestration of matter at the atomic and molecular scale to construct materials with new behaviors. Increasingly, one field is contributing to the knowledge base of another and boundaries that have historically shaped disciplines are becoming porous, enabling the exchange of experience and information productive to each. A classic example is the relationship between engineering and medicine, when Karl Culmann (1821-1881), professor of Engineering Science at the ETH in Zurich, and Julius Wolff (1836-1902), the German anatomist and surgeon, as they shared insight into each other's work. Culmann had recently developed the method of analysis known as 'graphical statics,' a means of visual/structural analysis based on vector scaling that was to become a standard within the engineering community for force calculation (Figure 1). It was from Cullman's drawings that Wolff predicated his hypothesis known as Wolff's Law [1]. His observations characterized the relationship of trabecular force trajectories within cancellous bone (interior structure) and bone loading. It was the visual nature of Culmann's work that enabled the transfer of knowledge from engineering to medicine. Our study is also based in the visual comprehension of the forces that generate patterns in architecture and nature.

Both Culmann and Wolff understood the relationship between material patterning, function and performance. Similarly, the work and thinking of Pier Luigi Nervi, (1891-1979) is rooted in the conceptual, creative and pragmatic understanding of material properties and their visual and structural patterning. Nervi's technical innovation and demonstration of the correlation of aesthetics and technology was due to familiarity and keen insight into the nature of materials, craftsmanship and methods of assembly. In his hands, the ordinary material of concrete became extraordinary. In his buildings, there exists a union of material, form, structure and pattern, and in these terms his buildings approach the organic. Masterful at making the flow of forces visual, Nervi called to question the similarities between artist, architect and engineer. While his structural patterns convey clarity of mind and a sound logic of construction, they are not the inevitable conclusions of formulaic thinking. Reason, emotion, decision-making, authorship convenes in Nervi's work. It is this agreement that was causal to Nervi becoming known, during and after the 1930's, as a technical artist.

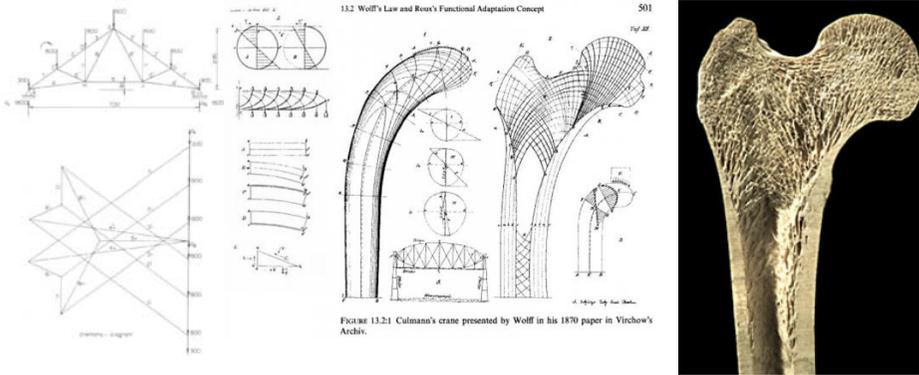


Figure 1 (left): is a Cremona diagram, a graphic system developed by Luigi Cremona based on the vector analysis work of Culmann.

Figure 2 (right): is a visual description of Wolff's Law that traces bone growth along principle stress trajectories compared to a cross section of a human femur, at right.

2.0 DESCRIPTION OF STUDY_NERVI'S PATTERNS

The intent of this research, as was Nervi's, is to study the balance of material properties, structure, available technologies, intuition and aesthetics. In this survey, it was (re)discovered that Nervi's patterns, while aesthetically compelling, are not based entirely on structural optimization. By working in a similar vein as Nervi, and by addressing the relationship of technology and aesthetics, this project seeks to look through his eyes with our hands. The question was how to gain insight into the spirit of Nervi's own working method to further current design thinking with contemporary computational tools and knowledge of pattern formation in nature. As a point of departure, three of Nervi's works were chosen for study: the concrete floor slabs of the Palazzo dello Sport, Rome, 1956 (figure 3a) and the Gatti Wool Factory, Rome, 1951 (figure 3b + c) and the rib patterns of the Palazzetto dello Sport, Rome, 1958 (figure 6). Evidence of Nervi's interest in the relationship of aesthetics and technology is present in these works.

During reconstruction of Nervi's slabs questions arose concerning the diversity of geometry found in Nervi's work. In the slab of the Palazzo dello Sport mezzanine (figure 3a + 4) the rib patterns concentrate on the center of the beam, a placement that increases moment and results in a higher quantity of material required for the given loading condition. Certainly Nervi was aware of this condition and made the conscious choice not to have structural optimization be the sole design determinant.



Figure 3 a,b,c: Nervi's work demonstrates a strong correlation between aesthetics, statics, materials and construction technology. This is evidenced in the mezzanine slab in the Palazzo dello Sport and the Gatti Wool factory. These have been studied to gain tangible insight into Nervi's intuition and working method.



Figure 4: Process of slab casting (Palazzo): 1) Finished plaster slab, 2) Silicon mold, and 3) CNC milled wax positive.

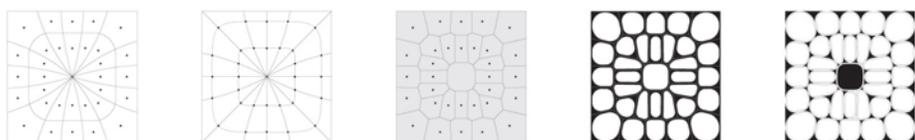


Figure 5: Example of the Gatti Wool Factory slab geometry with Voronoi patterning.

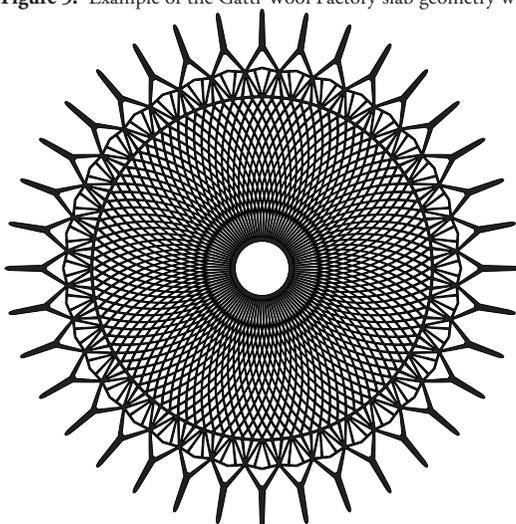


Figure 6: Reflected plan of the Palazzetto dello Sport. The radiating pattern was used as a generator for the morphological study on Michell patterning.

In Phase 1 we established a process to reinterpret Nervi's work by making drawings and scale models of the Palazzo and Gatti Wool slabs. Phase 2 is a morphological extension of Nervi's radiating rib pattern of the Palazzetto dello Sport as a generator and subject to the mathematics of Michell's Theorem {2} for optimal structural networks. Phase 3 was to morphologically extend Nervi's structural patterns with the Gatti slab as a generator and subject to the mathematical constraints of Voronoi patterning {3}. Both systems are found in the structural patterning of natural systems as diverse as the cross-helical patterning of sunflower seeds to the construction constraints of soap froth.



Figure 7: Construction photo of the Palazzo dello Sport, Rome. An array of precast elements form the dome.

3.0 PRINCIPLES_FORCE TRAJECTORIES

The guiding principle of Nervi's work, and by extension, this study is the supposition that force follows stiffness, illustrated in figure 8. The image to the right describes the force trajectories through a homogenous material with a hole. The image to the left describes force trajectories through an anisotropic material with trajectories 'attracted' to regions of increased density. Figure 9, a project by Professor Horacio Caminos, demonstrates the application force trajectories as the ribs are in closer proximity in regions of concentrated stress. The ribs collect force, as they are stiffer than the surrounding shell. In the last phase of this project, we apply these principles to the materials of carbon fiber and plywood and each are recognized to hold inherent properties implicit to their fabrication, the strength of weaving and lamination, respectively. Plywood was chosen for its relative low cost and ease of workmanship, carbon fiber was specified for its high tensile strength and capability to bond with plywood. Both materials are used frequently in boatbuilding to make lightweight and resilient hulls of complex curvature.

3.1. GROWTH AND NATURE

A tie to nature mentioned above is Wolff's theory on cancellous bone growth, positing that material deposition occurs along principle stress trajectories. According to Wolff's theory, greater and increased loading patterns result in denser regions of bone; the converse has also been observed, that light and infrequent loading results in more porous bone tissue. The orthopedic surgeon and researcher of bone biology, Harold Frost [1], observed that adaptive bone regeneration, known as remodelling, does not occur simply according to static loading but requires flexure, as a result of dynamic mechanical forces. He went further, with observed data from empiric experimentation; to describe the stimulus activated mechanical signaling that triggers biological response.

In 'On Growth and Form,' mathematical biologist D'Arcy Thompson states that form of an

organism is a result of intrinsic and extrinsic forces, a plastic and regenerative medium that is a transaction of genetic coding and environmental conditions. He observes that gravitational forces are significant for terrestrial animals, yet for aquatic animals, buoyancy prevails over gravity and pressure, as current and nutrient supply are principle determinates of size and shape. The structural lines of Nervi's architectural work bears similarity to patterns recurrent in natural systems and strikes an orchestrated balance of intrinsic (material properties, construction technique, economy and Nervi's authorship) and extrinsic forces (gravity). The intrinsic forces are fluid, fluctuating with advances in the imagination, materials science and construction technology, the extrinsic force of gravity is relatively constant. There is no explicit reference for Nervi looking at nature, though his work approximates nature's constructive technology in principle – that of effective material distribution.

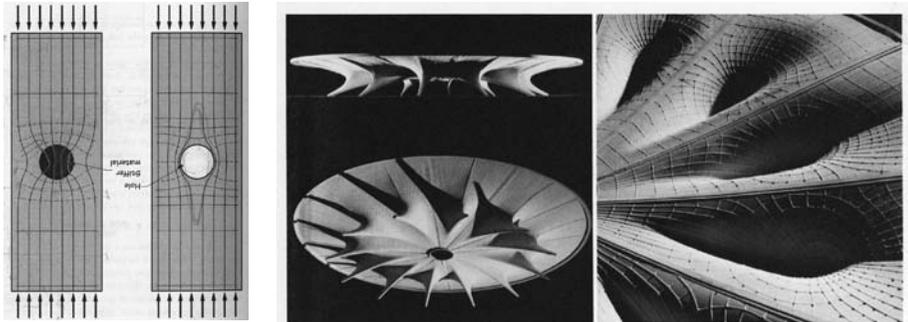


Figure 8 (left): Image from 'Form and Forces', by Edward Allen and Waclaw Zalewski, illustrating the principle lines of stress within a material subject to compressive loading. The image to the left graphically describes the isostatic lines around a hole; the image to the right describes influence on force distribution as the result of the insertion of a region of denser material. An interesting note is the similarity of the isostatic lines of image with the hole to fluid flow around a circular impediment. **Figure 9 (right):** Roof structure designed by Professor Horacio Caminos that economically distributes material along principle stress trajectories. The local thickening of the shell is designed to prevent buckling by collecting and distributing forces.

When observing nature's materials and methods of assembly where the structural patterning bears geometric similarity to Nervi's work there are two key conditions that are recurrent: 1) the principle of material placement according to stress trajectories and 2) that complexity is an emergent property based on these simple rule sets. The simple rules sets chosen for this study are Voronoi and Michell conditions for pattern formation.

4.0 SPECULATION

The following project is speculative and has been undertaken to more clearly understand the peripheral influences on Nervi's thought process combined with the teams' interest in drivers of pattern formation. Described below are the procedural processes used to replicate Nervi's slabs at model scale and to computationally extend the patterns he designed. In each phase of the project there is an aesthetic outcome derived from technological underpinnings. The ongoing goal is to uncover why Nervi worked the way he did, and why there has been relatively work since that is similar.

4.1 (RE)DRAWING AND (RE)CASTING

Our steps included 1) making accurate drawings from photographs of the built work, 2) transferring drawings to 3-D models, 3) cnc milling a wax positive, 4) pouring a flexible silicon negative, and 5) pouring a plaster positive (figure 4). Digital technologies expedited the process of mold making and enable the team to make multiple iterations of each slab. Although we were able to work more quickly, some knowledge was lost, as we did not think directly through the material itself, focusing

more on the technological process of making. The team recast several of slab designs, with effort placed on accurate geometric reproduction and attention to surface finish. The mezzanine slab of the Palazzetto is shown in figure 4.

4.2 MICHELL'S THEOREM

The second series of drawings and models were made according to Michell's Theorem that describes the optimal distribution of material for a given support and loading pattern. Of interest is that Michell's theorem leads to structural patterning where members act in 'pure' tension or compression. In nature, even though we assume efficient structural patterning, many systems, especially plants subject to wind load effectively use bending as a structural strategy. This is partly due to the desired attribute of resiliency in organisms and the properties of the soft and pliant materials organic life uses for construction. The rib patterning of the Palazzetto approximates Michell's Theorem of optimal structural frameworks, and this mathematical filter was used to develop new structural patterns in the matrix (figure 11). The variables that define each iterative pattern are number of ribs and rib curvature.

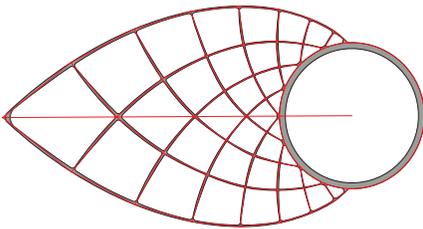


Figure 10: Pattern constructed according to Michell's Theorem for optimal material placement. In the cantilever above, the loading is downward at the point with support connections at the ring. The geometric patterning eliminates bending from the members and resolves forces to 'pure' tension and compression. If the diagram were to be of higher accuracy, the members would be straight lines.

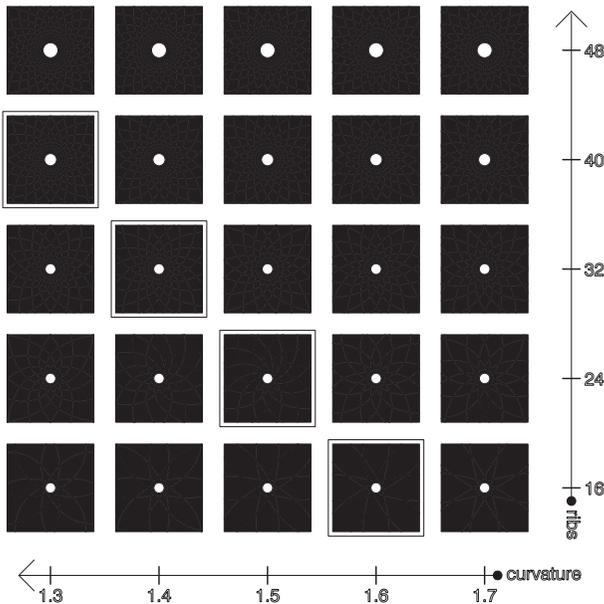


Figure 11: Image of a partial Michell matrix generated from the geometry of the Palazzetto dello Sport. The bordered diagonal series have been physically modeled.

4.3 VORONOI PATTERNING

A Voronoi pattern is determined by a line equidistant between two points and perpendicular to the shortest line connecting those two points. Voronoi patterning is a principle determinant in the material coding of both organic and inorganic natural systems. In the case of honeycomb construction the Voronoi pattern is a metabolically advantageous means of material distribution for the wasp, filling effectively with regular hexagons. The pattern emerges also in the choice of material placement of the sea sponge as shown in the micrograph in figure 14. In organic nature, as in our study, for a given loading condition, as cell number increases, cell size decreases and cell wall thickness decreases. This strategy makes an organic structure more versatile with the advantageous properties of lightness, strength and resiliency. Correspondingly a structure will be of higher 'frequency' and will either be lighter in weight or capable greater mechanical stress or be capable of longer span. R. B. Fuller demonstrated this principle in the design of lightweight and long span geodesic domes (figure 15).

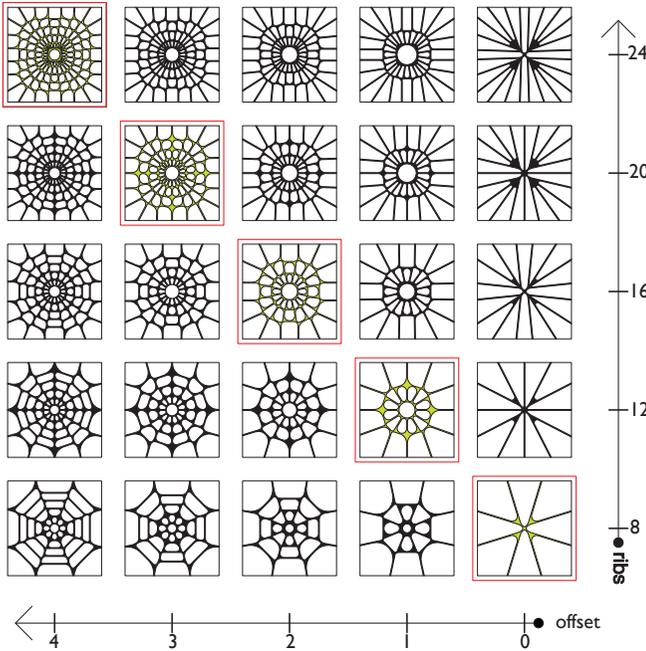


Figure 12: Image of a partial Voronoi matrix generated from the geometry of the Gatti Wool Slab. The bordered diagonal series have been physically modeled.

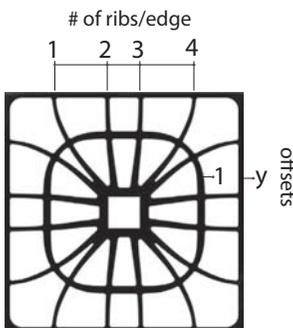


Figure 13: Diagram of the method for viewing the Gatti Wool Slab. The number of ribs and number of offsets are the variables in the matrix above.

The slab pattern was simplified with the variables being the number of edge points and the number of divisions along a radiating rib (figure 5 + 13). Each slab pattern was then constructed according to a Voronoi rule set (fig 12). The cellular patterns of Voronoi tessellations were chosen as the resultant patterns are aesthetically interesting and touch upon the relation of aesthetics or ornament and structure. This is relative, as Nervi did not operate wholly according to structural optimization but also relied upon economic and technological constraints and intuition to derive slab patterns. The relationship between aesthetic interests in Voronoi patterns is not random, and example can be taken from honeycombs, soap froths or the structural ribbing of insect wings. In the soap froth, the eye recognizes the natural beauty of a three-dimensional structure in equilibrium. The homogenous and elastic material of the soap film is unable to concentrate force and therefore equilibrates regardless of cell size or number.

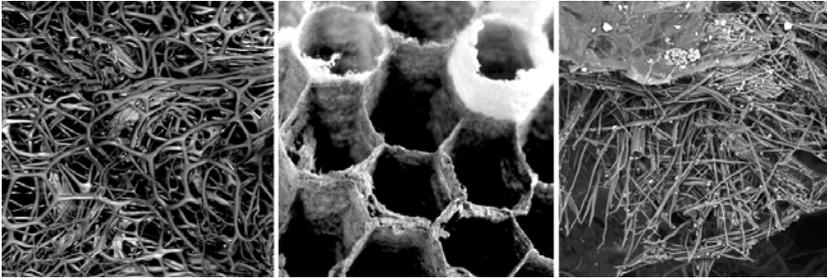


Figure 14: Scanning electron micrograph (SEM) of a sea sponge (1500x) of growth patterns according to Voronoi patterning. Close photograph of the nest of a paper wasp (center). The SEM at right is taken from a sample of the nest at center at 2500x magnification. The Voronoi patterns become less apparent at this magnification and we begin to see the mechanics of material distribution taken by the wasp.

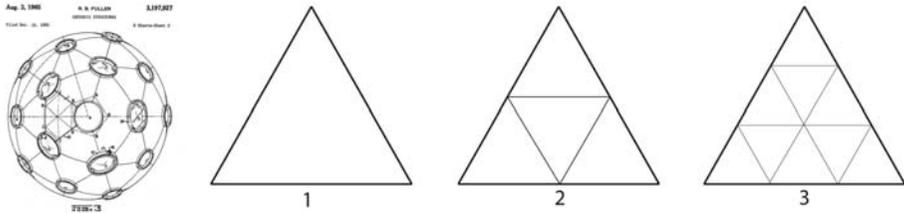


Figure 15: Frequency change in a triangle as demonstrated by R.B. Fuller in Synergetics.

5.0 MATERIALS, PROCESSES + FUTURE STUDY

The above geometric study will feed directly to a future material based study to construct medium span prefabricated construction panels from plywood. The fist, constructed from plywood and carbon fiber and derived from isotatic lines, is described below.

5.1 PROCESS_WEAVING + LAMINATING

The impulse to redistribute natural fibers to gain utility and strength has a long history in the development human technology. Basketry is one of the oldest crafts and engages human ingenuity to extend the structural propensities of natural fibers through patterning. The relatively weak singular reed is woven into a resilient composition that distributes load to a multiplicity of components and is therefore capable of withstanding significant load and wear. The structural key in the non-rigid system of the basket is load dispersal through effective patterning and redundancy, similar to the frequency change in the triangle above. The basket is certainly utilitarian, and as with all finely crafted artifacts, bestows status to the maker and owner in proportion to societal value placed on the artifact. A basket made by a craftsman embodies the wisdom of pragmatic and artistic

values and displays a history of innovation derived from variations in use, materials and methods of construction. The field of wooden shipbuilding advanced in much the same manner; the artifact was subject to continual qualitative field-testing and feedback loops, over time.

5.2 MATERIAL_ PLYWOOD

Wood gains structural ability most importantly from cellulose. The 'ose' in cellulose refers to its classification as a sugar, and its long linear polymer chain has much in common with sucrose. Cellulose is polymerized glucose, long molecule chains that form polysaccharides (many sugars). The long molecule chains assemble into micro fibrils to form a resilient network, giving the cell wall form and strength. In reference to Nervi's slab patterns, it is our intent to replace concrete with plywood in to construct medium span structural panels. As plywood, even loaded parallel to the grain, cannot compare with the compressive strength of concrete, the spans and loading will be commensurate. Plywood was chosen for its availability, low cost and ease of workmanship. It is a common material that, after studying Nervi's approach to design, we plan to use in an uncommon way; by increasing it's current span potential and visually expressing the load paths via isostatic lines. It is here that we hope to enter Nervi's territory – the space between engineering, architecture and art.

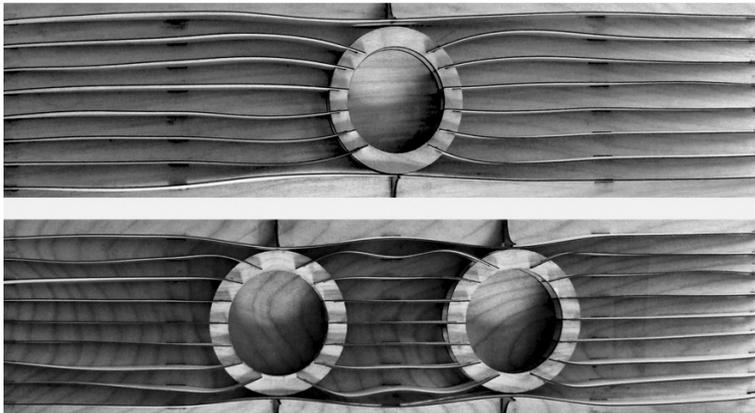


Figure 16: Initial plywood study derived from isostatic diagrams. The model is constructed at 1:10 scale and measures 6" x 24". It is expected that the hole could be removed from the plate as the stiffened plywood ring removes load from the inner region. Thin strands of carbon fiber are bonded to the tensile side of the 'beam.'

5.3 MATERIAL_ CARBON FIBER

Carbon fiber was chosen as a material of study as the material demonstrates the state-of-the-art in fiber technology in terms of tensile strength-to-weight ratio. A potential drawback of the material is that it does not yield resulting in sudden and catastrophic failure as the breaking point is exceeded. This combined with the materials high cost were reasons to reconsider the applicability of the material for architectural applications. The material has found contemporary architectural applications as externally bonded carbon fiber fabric and plate is used to reinforce existing concrete/masonry structural systems. The carbon fiber fabric is directly bonded to the concrete in this application as a means of noninvasive structural and earthquake retrofitting. The fibers, through the matrix of epoxy resin, also bond well with plywood. In our study, we expect carbon fiber or fiberglass to replace the steel of Nervi's reinforced concrete structures.

5.4 PLY/CARBON PROTOTYPE

Figure 16 describes the initial models constructed from plywood and carbon fiber based on isostatic lines. The first of a series, the models are thought of as 'anisotropic' materials. First the 'holes' were placed, then the stiffening rings added. The introduction of a hole weakens the material causing stress

trajectories to flow around the weakness. The introduction of the stiff ring around the hole increases the density of the material causing stress trajectories to seek regions of greater stiffness. With this phenomenon, the team plans to influence the physical and visual flow of forces through materials by selectively introducing regions of varying stiffness. Figure 17 is the first prototype from the Michell morphology made with a panelized plywood/carbon fiber system. The model is constructed at 15" x 15" at 1/2"=1' for a full-scale panel of 30'x30'. The ribs are epoxy resin with prestressed carbon fiber filaments bonded to the outer rib edge.

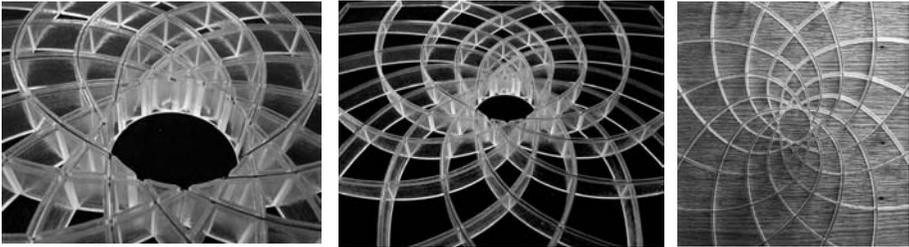


Figure 17: Resin/carbon fiber/plywood prototype generated from the Michell morphology. The prestressed carbon fiber strands are shown in the image at left.

6.0 CONCLUSION: AESTHETICS AND INTUITION

This study has sought to further Nervi's intuitive structural patterns through the prospect of morphology. In terms of aesthetics our ply/carbon prototype has a certain beauty. Perhaps this is because it references patterns found in nature that our eye recognizes as interesting. Specifically in the prototype references the patterning of the sunflower, which is not a structural reference. The ply/carbon model was also subject to many subjective decisions in its making including color, translucency and proportion, all of which are not the inevitable outcome of formulaic thinking. These decisions rely on an integrated emotive and rational process, which is advanced through the feedback making.

Nervi speaks of the "the mysterious affinity between physical laws and the human senses," calling to question the relationship of structural principles and aesthetics. It is assumed that intuition and structural constraints coupled with an awareness of the sensorial impact of material patterns played a substantial role in Nervi's own design thinking. Stanford Anderson reminds us that 'Tektonic referred not just to the activity of making the materially requisite construction . . . but rather to the activity that raises this construction to an art form . . . The functionally adequate form must be adapted so as to give expression to its function. The sense of bearing provided by the entasis of Greek columns became the touchstone for this concept of Tektonic.' Larger questions emerge concerning the ability of the eye to detect performative characteristics, in the case of Nervi, the effective patterning of material for structural purposes. Is there an optical interest in purposeful embellishment that augments a structural characteristic? If the Greek column were optimally shaped would the eye appreciate the entasis? According to Anderson's observation Nervi's work is strongly tectonic, elevating the functional deposition of material to an art form, positing him as a structural artist.

The question arose during this study of the bearing of Nervi's work on contemporary architectural thinking. The benefits in learning from Nervi are relevant today, as many designers have a strong interest in the relationship of aesthetics and performance tempered by material properties, construction technology and economics. Accordingly, this team aims to further the tangible relationship of aesthetics, material deposition, and technology – relationships that Nervi masterfully engaged.

ACKNOWLEDGMENT

This ongoing project would not have been possible without the close collaboration and creative insight of Joseph Koon and Aaron Chenault. Thank you to Rohan Rathod for his analysis and drawing of the Palazzetto dello Sport.

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END NOTES

1. Wolff's Law developed the theory that bone grows in response to stress or put another way, the internal patterning of bone is transformable and responsive to external loading from the environment. The converse is also true, that bone will degenerate if not subject to loading. The phenomenon is known as remodeling. In terms of an energy expenditure, it is not metabolically advantageous for an organism to maintain support where is not effective for survival. It is on this point that engineers and nature usually agree. More current research has shown the loading pattern is required to be a continuous series of impact loads, such as applied to the leg during walking, rather than constant.
2. Michell's Theorem mathematically describes optimal material placement for a given loading condition.
3. A Voronoi pattern is determined by a line equidistant between two points and perpendicular to the shortest line connecting those two points. Our reference has been to two-dimensional networks with three-fold and four-fold vertices.

IMAGE CREDITS

Figure 1	Luigi Cremona
Figure 2	Julius Wolff
Figure 3+6+7	Pier Luigi Nervi
Figures 4+5	CMU Bio_Logic Lab
Figure 8	Ed Allen, Wacław Zalewski
Figure 9	Horacio Caminos
Figures 10-17	CMU Bio_Logic Lab

Architectonics for evolving pastoralists: nomadic architecture and modern global culture

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ABSTRACT:

This paper seeks to establish a theoretical ground for the investigation of nomadic architectonics as an instructive instance of the taxonomic breadth of architectural space production. This research ties together theoretical threads from the work of Gottfried Semper on the textile wall to that of Gilles Deleuze and Félix Guattari on the ontology of the nomos, the smooth space inhabited by non-state actors. When nomads become sedentary, the evolution of their political economy creates a corresponding ontological shift in their understanding of space. Climate change and contact with modern global culture has accelerated this transformation, a cultural crisis articulated through an architectural vocabulary. It is precisely the nomos I seek to explore, challenging the romantic image of the nomad in Deleuze and Guattari's *A Thousand Plateaus* while benefitting from the philosophical notion of the nomos as a unique experience of space. This is a primary example of how philosophical critique can serve to engage a broader spectrum of built work than that for which architectural discourse normally allows.

CONFERENCE THEME: On Approaches: The Role and Use of Philosophy in Architectural Research

KEYWORDS: globalization, nomad, nomos, Deleuze, Semper

INTRODUCTION

Any investigation of space and of how humans situate themselves within it is essentially an architectural investigation. The goal is always to expand the understanding of *mind* or *self* in relation to space. This paper looks at architecture on the cusp of space and place, architecture as a way into larger philosophical issues of ontological space production.

Knowledge of the historical taxonomy of dwellings, like the syntax of languages, gives insight into the human mind. Language functions as an interface between an individual and the world shared with others. Syntax structures not just the rules of language, but also the rules of thought. Ferdinand de Saussure noted that if a certain word did not exist, for example, neither could its corresponding sound-image. (Saussure 1891) Conversely, once a word is learned, the sound-image it signifies cannot be erased.

Just as language shapes the structure of human knowledge, so does architecture. Each type of dwelling is a complex quotation that represents and reflects the particular properties of its socio-cultural milieu. Many of these dwellings tell minority narratives of background buildings, what might be described as non-monumental domestic or vernacular structures. The history of architecture is told by those who possess power. It requires power to assemble the knowledge, money, and material to build a lasting structure. Deyan Sudjic explains simply, "The powerful build because that is what the powerful do." (Sudjic 2005, 3) What is lost with time as more temporary artifacts disappear? What knowledge is deemed too fragile to have its history recorded in the annals of built form? What is lost in this sieve of dominance?

Architecture on the cusp searches for the most vulnerable structures—in this case nomadic dwellings—and creates a critical context for the spatial ontologies they represent. Two texts provide theoretical ground for this research and topical links between an investigation of nomadology and general architectural discourse: the 19th century writings of Gottfried Semper and a 20th century text by Gilles Deleuze and Félix Guattari, *A Thousand Plateaus: Capitalism and Schizophrenia*. While Semper's work gives context to nomadic architectonics, Deleuze and Guattari provide discussion of

the ontology of nomadic space. Their chapter, “1440: The Smooth and the Striated,” is one of the most influential texts in the canon of contemporary architectural praxis. I hope to demonstrate how a careful academic critique of such work can structure investigations at the edge of architectural discourse.

I. ORPHAN CONCEPTS

As successful as *A Thousand Plateaus* has been in disseminating its ideas across academic disciplines, the resulting scholarship and criticism has been equally frustrating. This is because, rather than invent new terms and new categories like so many of the thinkers of the first half of the century, Deleuze and Guattari choose to co-opt, bend, and distend existing terms and categories. Each term “sits astride standard categories and confuses seemingly distinct classifications.” (Bogue 2007, 113) The resulting interpretations of *A Thousand Plateaus* are as diverse as the disciplines that the work intersects, each responding with readings and misreadings that suit their own purpose. I cannot but assume the same will occur here. I will attempt to explicate and defend two terms of particular interest, *nomos* and *nomadology*, before calling them into service.

When referring to the “*nomos*,” Deleuze and Guattari cite Emmanuel Laroche’s text “History of the root *Nem* in ancient Greek,” which establishes the use of the word largely in the Homeric sense of land set aside for pasturage. (Laroche 1949) This is in contrast to the common use of “*nomos*” in jurisprudence and political philosophy, which establishes the *nomos* as a place ruled by a specific set of laws indicative of a particular language and culture, or *logos*.¹ In the chapter “1440: The Smooth and the Striated,” *nomos* is opposed against both *logos* and *polis*. Deleuze and Guattari transfer the common use of *nomos* onto the term *logos*, noting, “there is an opposition between the *logos* and the *nomos*, the law and the *nomos*,” thus preserving the sole definition of *nomos* as a kind of space. (Deleuze + Guattari 1987, 369) This space is “nondelimited, unpartitioned; the pre-urban countryside; mountainside, plateau, steppe” which is occupied by the shepherd or the farmer, as opposed to the partitioned, juridically-allocated space of the *polis*, the city, or, as the Bedouin say, the *hadara*. (Deleuze + Guattari 1987, 481) When referring to the *nomos* herein, it will be in this sense of nondelimited, smooth space.

“Nomadology,” then, is the investigation of people, particularly nomads, when within the *nomos*. A point of particular critical contention against *A Thousand Plateaus* is the misappropriation of nomads in the chapter “1227: Treatise on Nomadology—The War Machine.” Invocation of anthropologist Pierre Clastres confuses the philosophical abstract of the nomad in general with the representational nomad in her ethnographic particularities. Clastres’s text *Society Against the State* is of particular interest as a foundational source of ideas in the *Treatise*, of nomads as instigators of a “war machine” that opposes the formation of state-like socio-political organization. Deleuze and Guattari gain maximum traction from the foil of the nomad as an extra-state actor on a variety of social and cultural scales, and lose critical value when they invoke partial representations of the lives of real people, like Genghis Khan, inhabitants of the Amazon basin, or members of Bedouin tribes. Christopher Miller, in his 1993 essay in *Diacritics*, describes the disservice done to the study of nomadic peoples when the concept of “nomadology” is appropriated in such partial, preferential fashion. The romanticization of the nomad, as a pure being in non-juridical space, as a romantic warrior, as a representation of multiplicity and flow, is, from the pen of two French writers, a falsehood that represents a type of re-colonialization and subjugation of nomadic people, many of whom in North Africa fell to the French state.

If one strips away the specific examples of nomadic peoples from the “Treatise on Nomadology,” what’s left is a series of *orphan concepts*, philosophical tools pulled from a variety of sources that serve to organize thinking about space and the state, only the former of which is of interest here. To use such concepts again to discuss actual nomadic peoples, once acknowledging those concepts’ wrong-headed creation in a false realm of pseudo-anthropology, attests to willful ignorance. However, I have not found a similar set of ideas to adequately describe the specific type of non-place which the nomad occupies.² One may take a similar stance to the appropriation of biology in the contrast of “rhizomatic” and “arborescent” from the chapter “Introduction: Rhizome.” Actual biology is set aside, and only a shade of the truth of these organisms remains in a set of ideas appropriated to

explain notions of organizations of power. The difference between the rhizome and the nomad is that only the latter can be hurt by its becoming-orphan,³ not the former. Yet it seems equally misleading to accuse Deleuze and Guattari of writing willfully fake anthropology when they are combining mathematics, ancient Greek myths, texts on maritime navigation, ethnography, and art history in a strange amalgam never before encountered. To imagine that they believed themselves to be masters of any of these disciplines is to miss the actual purpose of the text: to borrow metaphors from a wide variety of sources in order to explain very schematic philosophical concepts. As Bogue explains,

...their effort is not to fix categories and demarcate permanent essences, but to make something pass between the terms of binary opposition, and thereby to foster a thought that brings into existence something new. (Bogue 2007,120)

Ergo; they are not concerned with anthropological accuracy except to the extent that specific instances of the nomadic life may illuminate instructive variations at the margins of the nation-state.

François Zourabichvili, in his text, *The Vocabulary of Deleuze* (2003), contends that even after two decades we do not yet understand Deleuze's terms as we have insufficiently explored his work in the context of the philosophical models he builds upon. It's important to remember that before embarking on *A Thousand Plateaus*, Deleuze published eleven texts of philosophical criticism, including *Bergsonism* and *Spinoza: Practical Philosophy*, the former of which is heavily drawn upon to define types of state power.

2. THE NOMAD AND THE NATION-STATE

2.1 WHO IS THE NOMAD?

The term “nomad” combines particular anthropological subdivisions, typically arranged by economic mode, thus expressing divisions between hunter-gatherers, herders, agriculturalists, traders, and wage-laborers. This type of division, the “classical model,” is refuted by the study of particular nomadic groups, which often exhibit several emergent forms of economy simultaneously, and whose individual members give evidence for “interdigitation” between these modes. (Galaty 1981) I use classical terms here with the understanding of their limitations.

In ethnographic literature, the three most dominant nomadic types are *hunter-gatherers*, who follow their food source seasonally; *pastoralists*, who engage in animal husbandry and move with the needs of the herd; and *peripatetic nomads*, craftsmen or performers living among and between sedentary people in urban areas and moving either seasonally or as dictated by the state.⁴ Each group may occupy permanent residences for parts of the year, and engage in extra-subsistence practices, benefiting from a symbiosis of overlapping territories and links between the *nomos* and the *polis*.

2.2 NOMADS VERSUS SEDENTARIES

Mounted pastoral nomads such as the Mongols or the Tuareg, while often scapegoated in western histories as conquerors who disturbed or dissolved peaceful cultures, actually represent a civilizing force that spread technology, written language, arts and ideas along trade routes across Europe and Asia. (Khazanov 2001) However, the image of the nomad consistently represents fear in western and eastern literature alike. In relation to modern nations, the nomad is a non-state actor whose existence is inconsistent with building national identity. Consider the Tuareg in central North Africa, who live in a territory that crosses five national boundaries. As Joseph Brodsky remarks, “That’s why a sedentary people always resents nomads: apart from the physical threat, a nomad compromises the concept of border.” (Brodsky 1985)

The “physical threat” is the stereotype of the nomad as barbarian conqueror, linked to Deleuze and Guattari’s disputed contention that the “war machine” is a product of nomadic society. Much of the critical outrage against *A Thousand Plateaus* is caused by the confusing use of the term “nomad” in relation to the “war machine,” for while Deleuze and Guattari reference nomadic military campaigns, they also lump supranational corporations, maritime expeditions and artistic movements into the category of non-state or anti-state actors, thus nomads. Furthermore, the “war machine” “does not necessarily have war as its object,” and “has an extremely variable relation to war itself.” (Deleuze + Guattari 1987, 416, 422) They include in their text, in fact, a lengthy disclaimer:

We thought it possible to assign the invention of the war machine to the nomads. This was done only in the historical interest of demonstrating that the war machine as such was invented... However, in conformity with the essence, the nomads do not hold the secret: an “ideological,” scientific, or artistic movement can be a potential war machine... a smooth space of displacement. (Deleuze + Guattari 1987, 422)

Deleuze and Guattari’s primary concern is to explicate two ontological tendencies, the nomadic and the sedentary, delimited by philosophical autotelic boundaries, and the conflict between them. These categories are transferred to show how the state uses the “war machine” in order to expand its jurisdiction across ever larger territories.

Regardless of the origin of the “war machine” or the first case of aggression between nomads and sedentaries, the modern nation-state does indeed view the nomad as a threat, an outlier contesting the centripetal exercise of its power. In response, the nation-state constantly seeks programs of “development” that serve to fold nomadic societies into the grip of state control, as was observed across Africa and Asia in the last five decades. The combination of state action and the recent intensification of environmental degradation has made pastoral life untenable in the few parts of the world in which it still exists. With accelerating rates of permanent settlement among pastoralists comes the loss of nomadic architectural forms and a shift in the ontological relationship between the nomad and the smooth space of the *nomos*.

2.3 NOMADIC ARCHITECTONICS

To find a critical entrance to the study of nomadic structures, I turn to the writing of 19th-century architect and art historian Gottfried Semper. In his exploration of the human impulse to build, Semper located the origin of architectural syntax in the use of hung woven fabrics, declaring the mere gesture towards visual partitions in space to be the most fundamental act of architecture. Even when building materials evolved, Semper contends “Wickerwork, the original space divider, retained the full importance of its earlier meaning... Wickerwork was the *essence of the wall*.” (Semper 1851, 103) Semper notes the instructive value of the nomadic tent in relation to the evolution of architecture, particularly in contrast to the arguments of contemporaries he finds lacking in rigor. He wonders why they do not stress what is critical about the nomadic tent, the use of the carpet as a wall:

...they overlook the more general and less dubious influence that the carpet in its capacity as a *wall*, as a vertical means of protection, had on the evolution of certain architectural forms. Thus I seem to stand without the support of a single authority when I assert that the carpet wall plays a most important role in the general history of art. (Semper 1851, 103)

Thus we arrive at an architectonics of textile partitions, what Semper called the *wand* wall, as related to the German *gewand*, or dress, most clearly visible in tensile design. The central thesis of the *wand* wall is the contention that woven partitions, not the structures between them, are the basic units of built space. Semper states that fence and tent builders understand the fundamental ontology of space:

...the use of the crude weaving that started with the [fenced animal] pen—as a means to make the “home,” the inner life separated from the outer life, and as the formal creation of the idea of space—undoubtedly preceded the wall, even the most primitive one constructed out of stone or any other material. (Semper 1860, 254)

Thus weaving the *wand* wall is the first act of creating what Heidegger calls the *raum* or *peras*, a place cleared for settlement or designated by a boundary; what Kenneth Frampton denotes as the *topos*. Semper’s notion that weaving as building is fundamentally linked to the “idea of space” is in conversation with Heidegger’s contention that “...spaces receive their being from locations and not from ‘space.’” (Heidegger 1951, 105) Thus as “the bridge gathers” the site around itself, a smooth space comes into existence as a location; becomes visible as a place. As Christian Norberg-Schulz explains, “The bridge gathers the earth as landscape around the stream... the banks emerge as banks only as the bridge crosses the stream,” concluding then that “The primary purpose of architecture is hence to make the world visible.” (Norberg-Schulz 1983, 433, 437)

While tent structures as appendages to solid ones, or as temporary pavilions in the landscape, are familiar forms in western architecture, only isolated populations of pastoral nomads rely on this syntax for the entirety of their built work. The architectural diversity these forms embody is rapidly

disappearing. If we lose them, we lose a piece of living architectural history, as “it remains certain *that the beginning of building coincides with the beginning of textiles*,” and clearly, with textile buildings. (Semper 1860, 254) Thus I emphasize the value of an architectural ethnography not just of nomadic forms (such work largely exists already), but of the ontology of the *nomos* as it relates to Heidegger’s notion of being-in-the-world, as a way to define dwelling.

Anthropologists have provided us with a catalog of no-madic forms—tents, yurts, huts—which detail the physical disposition of temporary, mobile dwellings, yet even these catalogs are incomplete and require amendment. As recently as 1999, Sébastien Boulay became aware of a minority architectural concept among the Moorish nomads of Mauritania, the *benye*. The *benye* is a small tent supported by arcing poles distinct from the dominant *khayma*, a large tent supported by vertical struts forming a pyramidal shape. In this culture the *benye* is mentioned as a negative to the *khayma*, as its inverse, as everything the *khayma* is not. Its primary use is as a heterotopia of crisis, in Michel Foucault’s sense of the term, an other place where taboo sexual relations are permitted to occur. (Foucault 1986) The *benye* may also be incorporated into the *khayma*, nested and layered within as a privileged space. Boulay’s conclusion is that even among pastoralists, “a particular architectural model is rarely exclusive and that secondary, more secretive models can coexist.” (Bouley 2007, 63)

In addition to the absence of such minority structures in anthropological catalogues, a detailed critical account of the notion of space itself as seen from a nomadic viewpoint remains elusive. This may be due in part to the dependence of western audiences on Euclidian notions of space, of points in space as places subordinate to the system of the Euclidian grid itself, places subordinate to locations. The ontology of the *nomos* is so far outside sedentary notions of space that structures built within the *nomos* are not commonly considered architecture at all, for they have no site, no location. As Deyan Sudjic suggests, the act of architecture in a sedentary context is an attempt to render systematic the innately chaotic:

Architecture has always been used to give those who build it the sense that they are able to escape the transience of existence, and to give it some sense of coherence. To place man-made objects in the landscape is one way to try to give them meaning; it is suggesting that they belong to a system. (Sudjic 2005, 379)

As nomads settle, as the space the nomad occupies becomes urbanized, we lose the notion of the *nomos as smooth space*. The resulting shift from an architecture of wand walls to the formal tectonic structures of the sedentary world represents a cultural crisis articulated through an architectural vocabulary. This is an opportune site for an expanded study of architectonics within larger philosophies of the nature of lived space.

3. SMOOTH SPACE

3.1 DEFINING “SMOOTH”

An ontological investigation of the *nomos* requires a better understanding of the notion of “*smooth space*” as described in *A Thousand Plateaus* in the chapter “1440: The Smooth and the Striated.” Because the smooth and the striated “in fact exist only in mixture,” Deleuze and Guattari seek to define the two through a series of “models.” (Deleuze + Guattari 1987, 474) In the Maritime Model, smooth space is denoted by *extensio* as opposed to *spatium*, a line between points, where destinations are subordinate to journeys, as opposed to a point between lines.⁵ The Portuguese, they argue, cite 1440 as the year of the “first decisive striation,” when maritime space was successfully striated due to accurate astronomical and geographical bearings. In the Maritime Model the sea, a smooth space par excellence, is striated by allocating its surface to points on a map.⁶

In striated space, one closes off a surface and “allocates” it according to determinant intervals, assigned breaks; in the smooth, one “distributes” oneself in an open space, according to frequencies and in the course of one’s crossings. (Deleuze + Guattari 1987, 481)

Thus the striated is space allocated before experienced, while the smooth is space experienced through varying distributions of actors during their journeys.

In the Technological Model, omni-directional, heterogeneous felt represents smooth space as opposed to unidirectional, homogeneous woven cloth. That nomads in the *nomos* employ both felt and woven cloth is cited as a mixture:

...the weaving of the nomad indexes clothing and the house itself to the space of the outside, to the open smooth space in which the body moves. (Deleuze + Guattari 1987, 476)

That the smooth can be heterogeneous is counter-intuitive. Smooth space is a model that permits local intensities, while striated space imposes universal sameness.⁷

The concept of smooth space is explained perhaps more succinctly in the *Treatise on Nomadology*:

The model is a vortical one; it operates in an open space throughout which things-flows are distributed, rather than plotting out a closed space for linear or solid things. It is the difference between a smooth (vectorial, projective, or topological) space and a striated (metric) space: in the first case “space is occupied without being counted,” and in the second case “space is counted in order to be occupied. (Deleuze + Guattari 1987, 362)

Another useful analogy for smooth space is presented in the first chapter of the book, “Introduction: Rhizome,” when contrasting the rhizome against the “arborescence.” The former is a horizontal network with no “privileged” center, each point connected to all other points, while the latter is vertical, hierarchical. The rhizome is a nomadic multiplicity, the “arborescence,” a uniform hierarchy.

Deleuze and Guattari note that nomads are not the sole inhabitants of smooth space, “even the most striated city gives rise to smooth spaces.” (Deleuze + Guattari 1987, 500) Iain Borden, in his architectural ethnography *Skateboarding, Space, and the City*, describes how skaters use body production to make smooth the striated terrain of the modern city, to create “super-architectural space:”

In place of the organized cosmos of architecture, classicism’s cohesion, internal hierarchies, imitation and balance, there are waves, vibrations and oscillations of skateboarding’s ludic procedures, suggesting conflict and contradiction, chaos and confusion, internalization of the external world, emotion and spontaneity. (Borden 2001, 112)

Borden’s text agitates for a study of smooth space, for a broader investigation of the *nomos* and those who inhabit it. He laments that for architects to reduce the study of space to the study of the architectural object is “a fetishism that erases social relations and wider meanings.” (Borden 2001, 7)

3.2 NAVIGATING SMOOTH SPACE

As a modern western individual, I cannot conceive of a system of space that lacks anchors; landmarks are necessary to define the boundaries of a known territory as apart from the unknown wilderness.⁸ Wayfinding systems exist in all cultures, be they minute observations of ecological conditions (wind, soil, temperature, density of flora, what Bogue refers to as “multidimensional signs”) or more precise triangulation using the stars.⁹ Is it then a romantic fantasy that the nomad occupies the *nomos* as smooth space? Bogue asserts it is not:

The Bedouins may follow broadly determined routes through the desert and seek out fixed landmarks, and in this sense they traverse a somewhat striated space, but the shifting sands of the landscape are in constant variation and their passage must precede along the unpredictable sites of scattered shrubs, bushes and patches of grass that serve as pasturage for their animals. In this respect, they inhabit the desert as a smooth space. (Bogue 2007, 126)

The contention is that despite the ability to navigate the smooth space of the desert, mountain, or steppe, pastoralists and their flocks nevertheless wander and move across this terrain as a flow or force, expanding to the extent of their capabilities, the contours of the pack morphing in continuous dynamic flux.

Perhaps one way of gauging the relationship of the nomad to the *nomos* is to determine her relative anxiety expressed upon entering or leaving smooth space. This seems to differ between pastoral cultures. For example, the Bouley notes that for the Moorish pastoralists,

...the nomadic life is considered dangerous, the desert being a sterile and empty (khle) space, inhabited by genies as opposed to the *bādiya*, more humanized and socialized environments. (Bouley 2007, 62)

It seems the tendency to striate what’s perceived as empty, chaotic, or unknown space is a pan-human one.

4. BECOMING SEDENTARY

4.1. RATES OF SEDENTARIZATION

Nomadic cultures have long had contact with sedentary ones, and exist along a “nomadism-sedentarism-urbanism continuum.” (Meir 1997, 7) Yet as Avinoam Meir notes in his study of Israeli Bedouin pastoralists, rates of change along this continuum accelerate with greater proximity to modern western culture. Globalization represents an existential threat to nomadism, one which gives exigency to the study of the *nomos*. As Galaty tell us,

It seems clear that unidirectional change has occurred in nomadic pastoral societies, in large part generated by a global setting of societal transformation and development, in the context of the market and the state. (Galaty 1981, 22)

For the Tuareg and their southern neighbors the *Sahelian Crisis*, a decade-long drought from 1960-1970, initiated a tragedy of the commons that dissipated their power to self-regulate and exist independent of the nation-state. Diminished land capacity resulted in the inability of local chiefs to limit over-grazing, to the detriment of the lives of the herd and the tribe. (Galaty 1981) Such environmental catastrophes reinforce the moral narrative of state programs of development, programs which take the place of traditional obligations for the care, protection and well-being of vulnerable members of the group (women, children, the elderly, the infirm). The state fills the void with social services—food, health care and education—which spark a concomitant desire for individualism and enhanced personal status free from older clan or caste systems. Development thus achieves a voluntary enticement towards modernization that protects the centripetal organization of the state against the centrifugal forces of nomadic life. In this new order, children become only consumers of resources rather than producers, the elderly lose their status and influence, and the newly sedentary population becomes dependent on the services of the state, hence easily manipulated by local governments.

In conflicts between the state and the nomad, administrative and development measures are set against de-centralized control of personal actions, modes of production, and movement across territory. It is the smooth versus the striated: de-centered, heterogeneous flows versus centralized, homogeneous control. The ontological notion of space itself is intertwined with these socio-political struggles. As Meir explains,

The centrifugal-centripetal tension stems from the conflicting nomadic and ethnic ideology on the one hand and the state ideology on the other. It stems particularly from opposing forces of space production. (Meir 1997, 9)

Whether forced or voluntary, the sedentarization and urbanization of pastoralists results in a loss of the cultural understanding of the *nomos*. A yurt in Ulaanbaatar, Mongolia that's been permanently fixed to the ground is no longer engaged in a cultural encounter with smooth space. (Sugimoto 2007)

4.2 SPECIAL CASE STUDIES

There are special instances of sudden urbanization that represent particularly instructive case studies for nomadology. These are the mining towns around Niger's Air Massif and on the Mongolian steppe. In these locations, at mines for uranium yellow cake in Niger, and for copper and gold in Mongolia, modern global culture has inserted itself whole into the *nomos* of nomadic pastoralists, many of whom remained until then at the far fringes of the development continuum. Leasing land rights to western actors has resulted in a radical confrontation between advanced industrial technology and pastoralists whom the state considers outside the circle of interested stakeholders. In some instances, this has resulted in violent conflict as waterways are tainted with radiation; in others nomads have settled and sought wage labor.¹⁰

When settlement occurs suddenly, is the ontological relationship of the nomad to the *nomos* transferred to striated space, thus smoothing it? Does sudden spatial change transcend the change in habitation from temporary to fixed dwellings, from an architecture of *wand* walls to solid architectonics, carrying with it the ontology of smooth space into the world of modern global culture? If so, this would be a fantastic counter-example to Deleuze's vision of the “society of control.” In *Negotiations*, Deleuze implies that the goal of modern global culture is an order that transcends divisions of space,

place, and language; an order in which the very production of identity, of bodies and their modes of being, are controlled and normalized. (Deleuze 1995) In such a world, the pastoral nomad could never again regain ontological links to smooth space. These mining towns are a potential exception to that assertion.

5. TAXONOMIES OF SPACE

In their study of contemporary Inuit culture, Genosko and Bryx report instances of smoothing as a form of cultural resistance to the striated practices of Canadian government administration. In their early attempts to take a census of the Inuit population, Canada's central government was frustrated by Inuit naming practices.¹¹ As a result, the government issued each person a number beginning with the letter "E," for "Eskimo." These numbers were issued on felt discs and had to be worn at all times, like dog-tags. This specific erasure of identity—it did not correspond to the system for Social Insurance Numbers issued to other Canadians—is an example of an "administrative convenience" as "endocolonialist violence." (Genosko + Bryx 2005) Since the abandonment of "E" numbers, Inuit have re-appropriated the system for use in various aspects of daily life, as codes for combination locks, as bank account numbers, or as non-consecutive numerical addresses in settlements without street names. In such cases, the Inuit "occupy without counting," as Deleuze and Guattari would say. (Genosko + Bryx 2005) The result is "a good example of 'melding' smooth and striated, of an impure intermixture, a Brownian address." (Genosko + Bryx 2005, 113) It is an example of cultural resiliency which demonstrates the flexibility of smooth space.

This melding shows that the ontology of the *nomos* can endure attempts at systematic striation by the nation-state. There exists an entire taxonomy of types of space embedded in the places between the radically pastoral and the entirely modern. Indeed it seems over time the smooth has made a lasting impact on the striated, as evidenced by IBM's 30-second "Data Baby" television commercial. The data baby represents an understanding of smooth space in modern global culture as a quantum expression of flows of data across the very surface of the human body itself, beginning at birth.¹² Like empires of the past, modern global culture's ability to adopt and re-appropriate the *nomos* will either help to preserve the diversity of spatial taxonomy, or hasten its demise.

CONCLUSION

The encounter between the state and the nomad is typically fraught with tension. The existence of nomadic culture challenges the very notion of nationhood. Here is a group of people for whom political boundaries have no meaning. They exist in the smooth Deleuzian space of ecological continuities, territories defined by the ranges of flora and fauna, by the texture of the land, by average rainfall. When nomads become sedentary, not only does their economy shift, so does their sense of the self in space. Just as nomadology is an ontology of the *nomos*, so too does a second ontology need to be explored, that of the nomad turned radically sedentary.

Proceeding from the theoretical ground established in this paper, I seek to gage the ramifications of radical urbanization on the tissue of nomadic life, searching for points of connection or dissonance between modern global culture and a vanishing way of dwelling in the world. Such an architectural ethnography would compare built responses intended to assist the transformation of nomads into sedentaries, revealing and bearing witness to points of maximum conflict between architectonic types. An architectural ethnography is both a compendium of forms and of notions of space. It is also a potential guide for the amelioration of the qualities of fixed settlements built by urbanized modern people for former pastoralists. In examining the fixed dwellings built to house former pastoralists near mining towns in the territory of the Tuareg in the southern Sahara, and the tribes of the Mongolian steppe, I seek remnants of the *wand* wall and the impact of sedentary architecture on the traditional understanding of smooth space.

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ENDNOTES

- ¹ See Cover, Robert M. "The 1982 Supreme Court Term, Forward: Nomos and Narrative." *Harvard Law Review* 97.4 (1983) 4-68, or Agamben, Giorgio. *Homo Sacer: Sovereign Power and Bare Life*. Stanford, CA: Stanford University Press, 1998.
- ² For a description of the non-place, see Augé, Marc. *Non-places: Introduction to an Anthropology of Super-Modernity*. John Howe, trans. London: Verso, 1995.
- ³ I use this term as a reference to the chapter, "1730: Becoming-Intense, Becoming-Animal, Becoming Imperceptible..." in *A Thousand Plateaus* to which Christopher Miller also strongly objected.
- ⁴ Additional types of nomads present in modern global culture include ambulatory groups of migrant laborers, highly specialized contract workers, and the mobile wealthy.

⁵ Heidegger also favored the term “extensio” over “spa-tium.”

⁶ Foucault called the sea-faring ship a heterotopia par excellence.

⁷ In their endnotes, Deleuze and Guattari credit the distinction “between two kinds of space-time” to Pierre Boulez’s texts on music theory. Boulez introduces the notion of the spatialization of time, time as represented as a series of points on a line, or instances, which determines a single time, but cannot give one the flavor of duration.

⁸ My conclusion is based on a personal anecdote of getting lost along the Great Divide in the Colorado Rocky Mountains in the summer of 2003. Upon reaching the Divide at the mountain’s summit, our trail disappeared into a field of rocks. The cairns that mark the trail in such areas were only partially present, and did not align with their positions on the map. Large spaces stretched between them. Even though our group knew in what direction we were meant to go; that is, along the ridge, along the divide; we could not overcome our anxiety at the lack of markers. We were overwhelmed by smooth space. Ironically, it began to rain as it often does on summer afternoons in the Rockies, and we were forced to scurry down the cliff into the seemingly larger smooth space of the forest to avoid lightening strikes. Yet the forest was like a sea of columns, of point markers, and we felt much more comfortable there.

⁹ Time is surely striated, even if space is not—we cannot stop the Earth from spinning on its axis or from orbiting the sun, thus days, seasons and years remain to ground a being in time even if lost in smooth space.

¹⁰ The Tuareg-organized Niger Movement for Justice (NMJ) most recently engaged in violent action in 2007.

¹¹ The Inuit often have six or more different names, none of which denote a surname or are gendered in any way.

¹² Matthew Cullen and Mth for Ogilvy & Mather New York. Part of IBM’s “Smarter Planet” advertising campaign.

Experiencing Architecture - Exploring the Soul of the Eye

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ABSTRACT:

This paper is an attempt to understand the influence of architectural settings on people; why certain architectural experiences stay with us whereas others vanish. It is a first step in an approach towards a greater understanding of subject and as such its starting point is purely theoretical.

We proceed the investigation by exploring two perspectives on the issue: a) a phenomenological perspective, based on the book “The Poetics of Space” by the French philosopher Gaston Bachelard and b) that of neuroscience. Both of these approaches view the human experience of architecture from starting points of the relationship between our mind and our physiological experience of the world. Neither of them separate physiological experience from the intellectual experience of place. Bachelard states in the “The Poetics of Space” that the psyche is a place, and the house is an extension of that place. He opens the door to places of significance to us, something neuroscience does as well. Both perspectives emphasize the early childhood experience of architecture which they feel has a major impact on the individual and his/her later environmental experiences, though they have different arguments for how this impact occurs.

The motivation to simultaneously investigate phenomenological and neuroscience approaches to architectural experiences is in order to introduce a new perspective on architecture and its impact on us. This new perspective on architectural experience could become a new approach towards a more humanistic and supporting architecture with the user in focus. How this approach would be integrated into architectural education is beyond the scope of this article as it is a theoretical discussion that only sets out to identify a problem in the architecture. It is a first attempt to approach architectural experience in a purely theoretical aiming to investigate questions such as:

- 1 a) Are certain architectural features or aspects of architecture more stimulating than others?
- 1 b) If so, what can explain their difference in importance for our experience of architecture?
And
- 2 a) Can a neuroscience and phenomenology approach combined improve our understanding of the architectural experience?
- 2 b) If so are there any practical implications of such understanding?

CONFERENCE THEME: Alternative approaches in research methods

KEYWORDS: humanistic architecture, architectural experience, neuroscience, Bachelard, phenomenology

INTRODUCTION:

Architecture has a great impact on us as individuals as well as a society. As we go back to our childhood there are certain environments that have stayed with us and yet others are brought back to us through smell, a certain ray of light or texture or a feel of a surface. This paper attempts to investigate how we perceive architecture and why certain environments stay with us whereas others vanish. Architecture touches us – the question is then how and by what means it touches us. The issue is here approached by applying two perspectives to the architectural experience: a) *a philosophical approach based on phenomenology*, and b) *a neuroscientific approach*.

I. TWO APPROACHES—PHENOMENOLOGY & NEUROSCIENCE

The reason for approaching the subject from two such different perspectives is that they both engage in human perception of the world. Philosophy offers us a method of understanding the world and our emotions in relation to the world in a rational way. Phenomenology, the science of phenomena and existence, is a certain field within philosophy that is intimately connected to architecture. It

investigates how we perceive and evaluate the environment depending on the environment's specific characteristics — the building materials and their highly sensory properties. That this knowledge is based on experience is fundamental to phenomenology. The phenomenological investigation of architectural experience is here based on the French philosopher Gaston Bachelard's *The Poetics of Space* (1958), which is a classic in the field. This work is particularly interesting due to the dichotomy it presents concerning considerations of the scientific mind: on the one hand its rationalism and search for truth, and on the other hand its reflections involving the imagination, daydreams, and poetic ability (Buyeron, 2010).

Neuroscience offers a complementary approach in this theoretical investigation of architectural experiences as our feelings and reactions to the surrounding environment are analyzed based on the functions of the brain and its response to different stimuli. The neuroscience researcher Antonio Damasio (1994; 1999) relates emotions to our mental images of the world, which according to him are nothing but functions of the brain. Neuroscience is a big field to explore—the fact is that we know very little about how our brain and mind interact with architectural settings; we suffer from both lack of knowledge and strategies for applying neuroscience in an architectural design. We do know that the human brain is one of the most complex objects in the universe and that from a neuroscientific point of view every experience, also our architectural experiences, are the result of activities of our brain, mind, and consciousness. Consequently, experiences are to a great extent unique to the individual depending on his/her genetic inheritance and lifelong accumulation of memories (consciously as well as subconsciously), but also depending on his/ her place in the world. The fact is that what we perceive is not useful to us until we have invested meaning in it and this is the result of the aspects described above (Eberhard, 2009, p. 84). We perceive the surrounding world through our senses of vision, hearing, smell, touch, taste, and proprioception (the ability to sense the position and movement of the body and its parts). These are the established senses, however, the exact number is debated due to different definitions among neuroscientists of what a sense is— some in fact identify more than twenty different senses. Nevertheless, of all our senses vision is the most active information-processing system. This dominant role in architectural perception is drawn attention to in the title of this article: “Experiencing Architecture—Exploring the Soul of the Eye”. The title also refers to Bachelard's views on space. According to Stilgoe, Bachelard enlightens us about ordinary spaces to the point that, after reading him, our own vision is altered and we see space with “the soul of the eye” (Stilgoe in Bachelard, 1994, p. x). The dominance of vision is manifested by the fact that nearly half of the brain's cerebral cortex is used to process visual signals, which is a higher percentage than any other of our sensory systems. I choose here to exemplify the complexity of our sensory systems by describing the process of the visual system.

The visual system operates with different parallel methods since the quality of light in a space is evaluated by the lumens (the amount of light), but also by our body's homeostatic system, which is self-regulated. The perception of how bright a light is perceived to be cannot be controlled by willpower; the body's response to light is instead determined by age and by other physical and psychological circumstances of the moment. The psychological dimension of the architectural experience is clearly illustrated by the perception of light among children who are afraid of the dark—for them it is only the presence of light that is comforting. Besides this, the perception of light is also determined by the spatial circumstances and the task that we are currently performing.

1.1. CHILDHOOD EXPERIENCES OF ARCHITECTURE

The child's experience of architecture is present all through *The Poetics of Space*. By recalling the child's experiences of home Bachelard uses the house as a significant spatial type for architectural experiences. He guides us back to ourselves by introducing us to those first experiences of the house, which influence our forthcoming architectural experiences. According to Bachelard the house is the original source of our architectural experience. We need it in order to imagine; it shelters day dreaming and protects the dreamer. He describes its importance from different perspectives. The simplest hut shines in its ability to shelter us from the storms outside; it even makes the storm good and enjoyable as it reminds us of the comfortable context in which we exist. Reading Bachelard one cannot help wondering why adults do not recall attic stairs from the top looking down but instead

recall them from the bottom looking up as Stilgoe reflects on the matter (In Bachelard, 1994, p. x). In childhood the texture of materials, the memories of our fingertips, as well as the details of the architecture at an eye level have a substantial impact on our experience of environments of significance. Our memories can be traced back to our body and not merely to our mind, according to Bachelard, who finds evidence for this not only in poetry and folktale, but also in psychology and even in ornithology. Using his own method he finds support for the argument that the house is the estate of our dreams, a shelter for the picture. In a phenomenological approach, Bachelard says, architecture is not only understood through its purported origin and function, but also through lived experiences. He introduces spatial types of significance to our architectural experience; these are the attic and the cellar, and the more intimate spaces such as drawers, chests, and wardrobes. The most personal and intimate spatial types are, however, the nests, shells, corners, and miniatures. Despite the smaller scale of these latter spatial types, they hold a universal meaning to us, he claims, and touch us on a highly personal level. The final spatial type he introduces is much larger in scale; this is the intimate immensity, which he views as a philosophical category of daydream.

Neuroscience, like Bachelard, is preoccupied with the early experiences in life and their effects on us. Research has shown that these experiences have physiological effects on the brain at a cellular level (Eberhard, 2009, p. 63). This, combined with the fact that cell growth during the first three years of life is more intense than during any other period, make the impact of these on the individual even greater. The majority of brain development takes place from the 28th day after conception through about the age of five. In the next period, however, from age six until twelve, major brain development also takes place. This period, for example, is critical for learning languages, which shows in an increased glucose consumption in the occipital and temporal cortexes in the brain during this period. Both these brain areas are important for vision and hearing. It is believed that children during critical periods of brain development are more vulnerable to environmental influences such as light and sound (Eberhard, 2009, pp. 63-66). It is known that the individual's sensitivity and the development of talent within an area is influenced by both environmental and genetic factors. Although environmental factors are rarely mentioned when musical talent is discussed, research has shown that musicians have approximately a 25% larger auditory cortex (the area of the brain that processes music) than non-musicians have and the earlier they have been exposed to music the bigger the auditory area of the brain is.

1.2. THE PERCEPTION PROCESS

An area called the Parahippocampal place area (PPA) is important for our architectural experience. In experiments Epstein and Kanwisher et al. (1999) have shown that this area responds more keenly to photographs of spatial settings such as rooms, landscapes, and streets than to photographs of objects, faces, and other kinds of visual stimuli. The response is also stronger to new places and spaces than to familiar views; the hypothesis is that this is probably where information about the layout of new places and spaces are encoded in the brain. The area is formed over a long period as more and more neurons are encoded as a result of the accumulated architectural experiences and the recognition of faces. Despite these properties the PPA is not involved in the process of way-finding, which one might expect.

The process called priming improves our ability to recognize and identify similar objects and experiences, is an unconscious process. Once an experience is primed, an ensemble of well-tuned neurons will handle the perceptual task resulting in a reduction in neural activity. As a result of priming, 45% of those who have been asked to freely associate to the concept of house will, when they are shown a list of words that include the word door, say "front door" (Eberhard, 2009, p. 121). After priming, the next level in the perception process is perceptual learning in which we differentiate the features of stimuli. This is how we by experience learn how to discriminate texture, direction of motion, line orientation, and other visual attributes. This occurs gradually over time in the visual cortex as the machinery of perception is altered. Perceptual learning is highly specific to the task and it seems to change the structure of the brain. The phenomenon of perceptual learning, together with the formerly described phenomenon of the larger auditory cortex among musicians, partly explains why experts perceive things in other ways than novices do. For example, musicians experiences music

differently than non-musicians do and landscape painters perceive trees differently than others. Also, architects to some extent experience and evaluate architecture differently than non-architects. This shows overall that Winston Churchill was more right than he perhaps knew when he said: “We shape our buildings; thereafter they shape us.”¹

2. MEMORIES & EMOTIONS

Since childhood we have stored architectural experiences unique to each individual, which become an inventory of visual memories overlain by emotional and sensory content. Similar to both the music and language experiences, the architectural experience depends on the individual’s ability to form categories of learned elements, to extract statistical regularities from rhythmic and harmonic architectural sequences, to integrate incoming elements (such as windows and doors) into syntactic structures, and to extract nuanced emotional meanings from visual signals (Eberhard, 2009, pp. 1621-162). This ability to categorize depends on the process of priming and on the perceptual learning described above, which both aim to efficiently process our surrounding environment. However, as they do not evoke conscious memories of the past, these perceptual changes are mostly outside of our awareness.

The phenomenological approach to our memories and emotions in relation to architectural experience is different. In *The Poetics of Space* Bachelard sees the home, derived from the concept of the house, as the basis for all our architectural experiences. He sees it as the base of our existence, since, regardless of our life situation on a psychological level, we always need to seek refuge and solace from the dangers of the insecure world outside. He explains: “The corner becomes a negation of the Universe” (Bachelard, 1994, p. 136). The spatial types defined as *the corner* and *the nest*, with their origin in the house are both, according to Bachelard, important for the human imagination of space – corner stone for our architectural experiences. He declares: “The corner in a house, every angle in a room, every inch of secluded space in which we like to hide, or withdraw into ourselves, is a symbol of solitude for the imagination; . . . it is the germ of a room, or of a house” (Ibid.).

Neuroscience describes how our physical body in combination with the structures that regulate our lives are continuously signaling our internal state. This is mapped in our brains together with events we have experienced based on the sensory and motor structures they in turn activate. These maps are recorded in neural patterns in our brains ready to become images. The function of these maps, according to Damasio, is to relate our bodies to mental images of our relationships with objects and events, and as such they are nothing but feelings (1994; 1999). Damasio’s theory is of the greatest interest in this investigation of memories and emotions in relation to architectural experiences. Damasio talks about what he calls primary emotions, which are automatic responses to objects or environments that are perceived as threatening to us. Examples of such emotional responses, which cannot be controlled, are fear and blushing. These primary emotions are followed by secondary emotions that reflect our cognitive interaction with the object or environment that produced the initial primary emotion. Merely by remembering an event that produced primary emotions, secondary emotions can be generated such as when strong architectural experiences from childhood are revoked. These secondary emotions derive from a guided disposition held in our memory that needs the primary emotions to express themselves (Eberhard, 2009). Eberhard means that due to evolution we are hard-wired to respond positively to harmony such as consistent orderly and pleasing arrangements of parts and we seek this in architecture as well as in music and in art. If this is correct we here have one explanation as to why humans respond more positively to certain perceptions and more negatively to others. Despite the probability of this theory holding true, neuroscience will never be able to find a specific center for good or bad architectural experiences. Instead, in all human response, there is most likely a set of brain activities across the brain that work similarly—like a symphony orchestra—playing a score that yields the music of bad as well as good architectural experiences (Jim Olds in Eberhard, 2009, p. 116).

When Bachelard talks about emotions in relation to architecture he describes it as though certain emotions cannot be stopped. They arise unconsciously within us, he says, and the mere “whiff of perfume, or even the slightest odot,” can create “an entire environment” (Bachelard, 1994, p. 174). He exemplifies this by saying that for a man who lives in the woods and the fields the discovery of a

nest is always a source of fresh emotions and means that the strong emotions evoked by the nest bear the mark of sincerity (Ibid.1994, p. 96). The reason a nest evokes such strong feelings is that, like any animal shelter, it evokes well-being and our image of the house, which, according to Bachelard, is engraved in our muscles.

Information about our surrounding environment reaches us through our senses, but it is not until the information is associated with memories and emotions that the actual perceptual process takes place. It is only then our mind has associations to what we experience and recognition, i.e. when our mind locates the specific memory, that the information matters to us.

Research has shown that the manner in which we emotionally evaluate information has a great impact on us, since emotionally arousing events are remembered especially well. This is why an architectural experience of e.g. the Notre Dame Cathedral in Paris is more likely to be remembered by you if Bach is played from the great organ the first you enter it than if no music is being played (Eberhard, 2009, p. 123). Eberhard relates this phenomenon to the fact that the brain establishes future memories, the so-called *long-term potential* (LTP), by binding the neurons in the brain together for the benefit of any future activities that come along the same path. In the brains of children studying their ABC or performing music or tennis, the brain guides visual, aural, and musically strong experiences that produce series of LTPs. According to Eberhard, this phenomenon may explain why some buildings or areas with strong architectural features are memorized from the first time we saw them in photo or physically visited them. Every time we see this building or environment, or any similar building or environment, this image is reinforced and these series of LTPs are then reproduced in the brain.

This process of external stimulus through our sensory systems (e.g: the visual, the auditory, and the tactile), which is filled with emotional content, takes place in the limbic system—the “emotional center” of our brain. Neuroscience studies have shown that we experience emotions before we are consciously aware of them (Eberhard, 2009, pp. 192-193). In order to guide our behavior the limbic system provides both encouragement (a carrot) and punishment (a stick). We respond with positive emotions such as affections, love, and pleasure to stimuli that are perceived as positive, and with negative emotions and behavior towards negative stimuli such as events that threaten our well being, our survival, or our sense of fair play. This emotional learning occurs in two separate systems of the limbic system: the amygdala and the hippocampal systems, and they support non-declarative emotional memories as well as declarative memories (Squire & Kandel, 1999). Though these two systems mainly work independently they also sometimes work together.

The so-called subcortical pathway processes events that require rapid responses and in the cortico-amygdala provides information that is used for the cognitive evaluation of events and environments, which takes place prior to any rational decision being made. This process of converting non-verbal tracks in our mind into words and sentences cannot be stopped. The internal process of emotions and memories related to these leads us to the key aspect in the perception of architectural experiences and other exterior stimulus namely consciousness.

3. CONSCIOUSNESS

The experience of architecture must be understood in the context of consciousness, which in turn relies on the internal construction and the interaction between the individual and the object/environment (Eberhard, 2009). Consciousness begins as a feeling which arises when we see, hear or touch an object that is associated with personal images (Eberhard, 2009, p. 123). The concept of consciousness goes back to the French philosopher Descartes who in 1637 stated: *Cogito ergo sum*: “I think, therefore I am” or “I think, therefore I exist.” The statement recognizes the centrality of ontology (what is) and epistemology (what and how we know) in consciousness.

In the establishment of primary consciousness our short-term memory is involved, which incorporates memories from the past including a categorization of the present. The short-term memory is by Eberhard referred to as the “remembered present,” which entails that the present perceptual experience of architecture is linked to past experiences of a similar space, or a space that evokes the same feelings. It is this linking process that leads to consciousness and the result is unique for each individual. It is prioritized by our value system as it contributes to continuity in our lives by relating our memories to

the current situation, which, according to neuroscience, explains why it has been conserved during evolution. This process is by Edelman and Tononi (Edelman, 2000) called high consciousness, and it was added to our primary consciousness when we as a species acquired language; with language we had the need to think about the past, reflect on the future, and be conscious of the present. In this context it is important to know that humans are as far as we know today the only creatures that can use the mind to think about the past, contemplate the future, and be aware of being aware.

From Bachelard's point of view the architectural experiences are not fully individual as they also hold an element of universality. A phenomenological inquiry is necessary in order to understand the architectural experiences since this approach includes our "sentimental resonances by which we receive a work of art" (Bachelard, 1994, p. xxii). The architectural experience, according to Bachelard, happens through the *poetic image* defined by certain spatial types that evoke them. (For spatial types defined by Bachelard see above). He claims that: "short-lived event[s] constituted by the appearance of an unusual poetic image, react on other minds and in other hearts, despite all the barriers of common sense, all the discipline schools of thought" (Bachelard, 1994, pp. xviii-xix). Poetry is a commitment of the soul. Therefore, while studying the phenomena of the poetic image, the mind has to be incorporated since the two are indispensable to each other. All our senses are effected by the spatial types defined by Bachelard, and these types are tightly linked to our architectural experience since they emphasize the existential part of our lives. An example of this is the spatial type *miniature*, which, due to its causality of smallness, appeals to our senses. Our fascination with miniatures and other spatial types demonstrates the tight connection between the world of imagination and our senses. But also, the opposite to miniatures, the spatial type called "the intimate immensity," in his opinion, means a lot to us on an existential level. This spatial type reveals the depth of life in the vast subject of contemplation when "the exterior spectacle helps intimate grandeur unfold." (Bachelard, 1994, p. 194).

Since response to architectural experience is largely unconscious, and different environmental factors influence our perception, the perception process is highly complicated to investigate. Using the visual perception process as an example, the quality of light in a space is not only evaluated by the amount of light (lumens) that sends signals to our brain, but also by the homeostatic system of the body. The perception of brightness is not controlled by willpower in any part; instead, our physiological response to too much or too little light depends on age as well as the circumstances at the time. This is why you need less light if you are sitting quietly listening to music and reading than if you are trying to read the small print on the label of a medicine bottle (Eberhard, 2009, p. 82). There are physiological aspects to the perception of light as well. Studies of light effects in school environments have shown that light makes children both more active and more social (Küller & Lindsten, 1992). An example of the psychological dimension of visual perception is that a child who is afraid of light will find comfort merely by the presence of light alone. Architecture's effect on cognitive processes and the ability to concentrate is especially clear in terms of children with deficient sensory integration or hearing and sight impairment. As they cannot see or hear well in certain environments, specific school environments will delay their reading ability, which is a key factor for successful learning (Eberhard, 2009). In Sweden the awareness of the impact that architecture has on pedagogic settings early on led to a specific kind of school architecture, which can be recognized by the large and highly placed windows of the schools. These features of the classroom architecture provided for a good daylight illumination and minimized distractions since the pupils could not look out and see the exterior environment.

Consciousness is the key to understanding the individual's architectural experience but since the human brain, one of the most complex objects in the universe, is not fully explored today, consciousness is not entirely understood. Consciousness is unique due to its flexibility to process new information in creative ways and its ability to relatively quickly adapt to changed conditions. Discussing consciousness and the human brain one needs to be aware that the *mind* is not a synonym for the *brain*. The brain is instead an instrument in the perception process. According to Eberhard, it is the human ability to think about the past and future and to be aware of our own awareness, as described above, that is expressed in the human desire to create architecture: "No other species creates habitats or communities that are as elegant, as structurally daring, or as functionally diverse as ours (Eberhard, 2009, p. 181). This is noticeable in the fact that no other species produces building designs

like Michelangelo's according to Eberhard. The aim of this paper—to investigate the architectural experience—could very well be regarded as yet another expression of this human striving.

4. DISCUSSION

This paper argues that in order to improve the human condition it is necessary to recognize all of our sensory senses in the design process since these senses form the basis of how we experience architecture—an experience that includes our mind, soul, and body. In the architectural profession there is, however, a single-minded focus on the visual side of architecture, a focus that already suffuses architectural education. The students' projects are mainly judged by the teachers' visual perception of projects and in architecture magazines, which are read by students as well as practicing architects, projects are often mainly described by means of photos. This single-minded focus on the visual aspect of the architectural experience is further emphasized by the fact that the architectural quality of a building in architecture competitions is often assessed by the jury based on photographs alone and not on the actual experience of a building (Eberhard, 2009). To evaluate the quality of architecture only by means of the visual image, however, is like "falling in love with the photographs of a person without ever meeting him or her," according to Eberhard. To evaluate the quality of architecture by the use of only the visual image is however like "falling in love with photographs of a person without ever meeting him or her" as Eberhard says (2009, p. 78).

A thorough analysis of architectural education is essential to break the focus on the visual side of architecture in order to find different teach and design methods to achieve a more comprehensive architecture. How this can be done is however outside the scope of the paper as it is a theoretical discussion that seeks to identify a problem in architecture and not present methods of how to integrate the architectural experience in architectural design, i.e. theory, practice, and pedagogy for this. The paper should instead be regarded as a first step in a larger investigation that hopes to find methods for a more comprehensive architecture.

The power of architecture is believed to support social ideals, human needs, physical health, and spiritual aspirations. With the aim to fulfill the various dimensions of human needs that are linked to architecture, different environment-behavior methods have been applied to the profession, e.g. Evidence-based design, Post Occupational Evaluations (POE) or User need studies (Eberhard, 2009, pp. 173-179). None of these methods focus on the sensory dimension of architecture, which is a shortcoming in my opinion since the architectural experience to a great extent is a sensory one that includes all our senses and not only vision. The complexity of sensory experience, however, recognized by two such diverse fields as neuroscience and the philosophical field of phenomenology, which are both founded in lived experiences and regard our sensory experience as a key factor for our perception of the world. Both fields tie our mind and soul to our feelings and to our physiological experience of the surrounding environment.

Like Eberhard I believe that we have found a tool for the design process in neuroscience. The rapid development of neuroscience will not only help us understand the interaction between the human mind and different architectural settings, it will also offer the energy and vitality which a "new", dynamic, and highly innovative field of science holds. By combining this field with phenomenology, the risk is less for the sensual and the imaginary dimension of architecture, so well described by Bachelard, to get lost. The two approaches combined invite architects to base their work on the human experience of architecture, and this may possibly be a method to achieve a humanistic architecture, rather than on an architecture based on abstract motives that may or may not affect viewers and users of the architecture. An architecture of the imagination is an architecture that involves the whole person—body and soul—and thereby a more "real" and humanistic architecture. To stress the central role of the human psyche in this approach I want to end this paper by quoting Bachelard: "the human psyche contains nothing that is insignificant" (Bachelard, 1994, p. 135).

BIOGRAPHY

Architect Christina Bodin Danielsson, PhD, is teacher and research at The School of Architecture & Built Environment, The Royal Institute of Technology (KTH), Sweden as well as researcher at the Stress Research Institute, Stockholm University. Her research interest is how the architecture influences humans in different settings. She has a special focus on office environments influence on employees and organizations. She also works as a practising architect specialized on offices at Brunnberg & Forshed Architects Ltd, Stockholm.

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ENDNOTES

¹The quote comes from a speech Churchill made in the House of Commons on October 28, 1944. According to author, Dr. Mardy Grothe, the original quote was: "We shape our dwellings, and afterwards our dwellings shape us." (http://wiki.answers.com/Q/When_did_Winston_Churchill_say_you_shape_your_buildings_thereafter_they_shape_us#ixzz1By4ZRx4H). Date: 2011-01-24

Giedion's Figural Conception of Urban Space-Time & The Analysis of Le Corbusier's Modern Urbanisms

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ABSTRACT:

Sigfried Giedion's presentation of three figures to analyze urban space-time in history can be used in turn to understand often overlooked aspects of early modernist urban schemes, like Le Corbusier's Plan Voisin, the Pavillon de L'Esprit Nouveau, and the Contemporary City for Three Million Inhabitants. Giedion identifies a need for understanding the new scale of industrialized urban space-time with a synthetic frame of reference necessitating the movement and memory of a sentient viewer. This need had already been felt by avant-garde artists of the early twentieth century, with Cubist and Purist pictorial space presenting the viewer with a synthetic, simultaneous space by fracturing the picture plane and challenging the transparency of linear perspective. Recognizing that Le Corbusier utilized this synthetic viewing frame to produce his paintings and organize his buildings, exhibits and texts allows for the construction of an alternative history of Modernism that may be more useful to contemporary urban planners than the usual recourse to oversimplified caricatures of a history governed by the static frame.

CONFERENCE THEME: On Approaches

KEYWORDS: Le Corbusier, Giedion, urbanism, figure, invention

INTRODUCTION

In his lectures on modernism at Harvard University in 1938-39, Sigfried Giedion described historical conceptions of urban space and time using emblematic spatial arrangements (Giedion 1949). Medieval urban space-time was summed up by the leaning Asinelli and Garisenda towers in Bologna; Renaissance space-time found culmination in the nineteenth century through the perspectival spaces of Haussmann's boulevards cutting through Paris; and contemporary, modern developments in urban space-time could be previewed in Cubism and Rockefeller Center. Giedion used the space-time figures to uncover an imperative in contemporary urban planning to think at increasingly larger scales, a space-time necessitated by industrialization.

As an example of an alternative approach in architectural history research methods, Giedion's space-time figures of the historical urban subject can be used to analyze Le Corbusier's urbanisms. By looking at Le Corbusier's controversial publications on urban planning using the topical framework of Giedion's figures, we can find evidence of a non-perspectival, synthetic or collaged space of representation. This idiosyncratic manner of presenting urban space corresponds to Giedion's utilization of Cubist collage techniques to communicate what were still new possibilities for thinking about large scale developments, possibilities implied in the dynamic public spaces of Rockefeller Center and a new scale of space introduced to the city by the parkway. The spaces of industrial society, the scale and complexity of new transportation networks, are too vast to be communicated from a fixed point, a single view obtained by looking along a primary axis conveniently provided by the architect or planner. According to Giedion, the synthesis of heterogeneous and sometimes contradictory spatial experiences into the image of a larger system, be it a single modern building or the entire city, must take place in a synthetic frame constructed in the mind of each subject. An inventive agency is required to gain understanding of contemporary space-time.

The ingenious conceptual structure that Giedion used to communicate the new problems of the modern city was also used by the modernists whose work he studied and presented to the world. In attempting to solve the problems of the industrial city, the avant-gardes of the early twentieth century sought new methodologies when existing conceptual tools seemed to quickly become obsolete. Le Corbusier, as a prominent revolutionary artist and architect/urbanist is a good example

of the development of new space conceptions in art preceding corresponding developments in architecture and city planning. The dynamic frame of Cubist and Purist synthetic space was a key component of Le Corbusier's later urban methods. This can be seen from early representations of his urbanism, such as the *Plan Voisin* exhibited in 1924 as part of the *Pavillon de l'Esprit Nouveau* alongside a prototype housing unit, and later in publications like *Precisions* (Le Corbusier 1930), *When the Cathedrals were White*, (Le Corbusier 1937) and culminating in the massive tomb, the *Poem of the Right Angle* (Le Corbusier 1955). These works describe a trajectory that grows increasingly obscure, but more importantly, the format Le Corbusier chose for these works indicates aspects of the invention of a modern urbanism radically different from that presented in more famous works with very different, highly didactic formats. These didactic works include CIAM's *Athens Charter* (CIAM 1938; Le Corbusier 1973), and the plans and perspectival renderings of innumerable cities produced by Le Corbusier's studio.

This paper will first summarize Giedion's three figural frames and discuss their implications for modelling urbanity as an object of knowledge. Then, we will examine one of Le Corbusier's early format-experiments, the *Pavillon de l'Esprit Nouveau*, to show how the application of Giedion's figures can reveal new opportunities for understanding historical precedents, finding the thread of continuity for more obscure aspects of modern urbanism.

I. GIEDION'S THREE FIGURAL FRAMES

I.1. THE TOWERS OF BOLOGNA

The Asinelli and Garisenda towers in Bologna date from the early twelfth century, and eventually the city would have nearly 100 towers, with construction and modification reaching a fevered pitch by the end of the fourteenth century (Jones 1997). Exactly what significances Giedion invests these towers with is as obscure as the origins of the towers themselves, but he makes it clear that being able to view the interrelations of the two towers in space, leaning toward one another at the intersection of five streets leading to gates in the city's walls - a relationship easily comprehended from any number of stationary points in the city - indicates a manner of understanding the city in the time and space of a historical subject.

[T]he leaning towers of the two noble families of Asinelli and Garisenda in Bologna ... can be embraced at a single glance, in a single view. There is no uncertainty in the observer concerning their relation to each other (Giedion 1949, 641).

So, what does this figure tell us about medieval Bologna's space and time? It is indicative of what we might call a "clotting" of the space-time of the city. The many towers of Bologna date from the height of the Investiture Conflict that pitted groups of noblemen throughout the Holy Roman Empire against each other, siding either with the sovereign power of the Emperor or the Pope. In Northern Italy, local noblemen, merchants, or prominent families asserted their bids for local power amidst the chaotic alliances. The political, social and economic consolidation of Italian city-states into relatively independent, localized systems of governance was contemporary with the questions of sovereignty and right of rule and law implicated in the conflict. The particular form of urbanity that would eventually emerge as the northern Italian City-State by the fourteenth century, a form that is legible at the macro scale of the city and its surrounding lands, was fraught with violent clashes between clans within individual cities (Martines 1979; Hyde 1973).

The internal rivalries raging in cities like Bologna in the twelfth and thirteenth centuries produced an extremely divided urban environment, where it was common for people to live their entire lives rarely setting foot outside a single neighborhood populated by familial relations. This divided or "clotted" urban social sphere was pervasive and prolonged enough to produce detectable variations in spoken language, such as different accents, in the different neighborhoods of Bologna. Dante mentions these differences in speech, sometimes tied to an urban space only a few hundred meters in diameter (Martines 1979).

The towers of Bologna were used as spatial tools tying a clan to a particular space in the city, aiding in the ability to protect and defend the surrounding buildings from rival factions. Most frequently it seems, objects were thrown or dropped from the tops of the towers, easily injuring or killing

pedestrians on the open streets below. This activity was so common as to result in specific laws punishing anyone who dropped objects from urban towers (Martines 1979). The clan-space indicated by the towers was contingent on physical lines of gravitation and bodily occupation. The physical manifestation of a clan's dependency on the tower as a spatial-gravitational tool is exemplified by the unusual practice of building bridges and flyovers connecting various buildings within the family neighborhood compound directly to the tower. The urban space of the city-state in formation was dependent entirely on occupation via physical contact. Visual or measurable distances were irrelevant in this localized and haptic space. Each local system, every family clot, obtained global legibility through cohesion by physical proximity and a need for global validation at the scale of the City-State for protection against vying family systems. The city that produced the Asinelli and Garisenda towers had little use for the abstracted, homogeneous and infinite concept of space that would emerge during the Renaissance.

1.2. PERSPECTIVAL SPACE OF THE PARISIAN BOULEVARDS

For Giedion, the linear network of Haussmann's boulevards cutting through the dense fabric of the ancient city is a grafting of the abstract homogeneous and infinite space of Renaissance linear perspective onto the urban environment (Giedion 1949). Thus, the nineteenth century Haussmannization of Paris is a late expression of Renaissance space-time, brought to bear by a series of rulers on the clotted space-time of medieval urban neighborhoods.

When Haussmann was appointed to the position of Prefect of the Seine Department by Napoleon III in 1853, the work of making Medieval Paris correspond to the industrial age and the rule of the Empire had already begun. For Giedion, documenting the series of rulers who commissioned the changes of Paris in the nineteenth century was necessary to show the slow unfolding of power-relations indicated by each urban invention, stretching back at least to the developments of Louis XIV which introduced large-scale Baroque space to the city's environs. Under the Second Empire, Napoleon III would immediately begin attempts to systematize the extension of Renaissance space through the existing city. These early attempts were initially plagued by embarrassing failures in engineering and surveying, leading to Haussmann's appointment as a qualified planner who would support the Emperor's expensive plans.

The Haussmannization of Paris corresponds to the city's industrialization performed through perspectivation. The development of the boulevards began as a process of extension and connection of urban elements. First came the 1854 extension of the Rue de Rivoli to stretch from the Tuileries to the tangled mass of streets and buildings in front of the Hôtel de Ville. This dense neighborhood, which had previously been the starting point of various Parisian revolts, was replaced with the open space of the Place du Châtelet (Giedion 1949). In 1858, the wide, arrow-straight Boulevard Sébastopol was extended to connect the Île de la Cité to the Gare de l'Est, connecting the new administrative center in the middle of the city to the new railroad station on its north-eastern edge by a tree-lined, space bounded in the distance only by perspectival convergence. The Rue de Rivoli and the Boulevard Sébastopol, connecting to the Boulevard Saint-Michel on the south side of the Seine, intersect in the center of the city to form "*la grande croisée*", effectively establishing a large-scale, linear and homogeneous access-space within the medieval city fabric of Paris.

Like the medieval, clotted space-time figured by the Asinelli & Garisenda towers, the space-time of the Boulevard requires only a static frame of reference for comprehension of the city. An individual placed anywhere within the monumental Boulevard-spaces of Paris can view a linear, occupiable space extended through the city, bounded only by the optical convergence created by the individual viewer as an entity occupying the space. That this perspectival figure is created only by literally carving or cutting through the densely clotted space of medieval Parisian neighborhoods makes it enough of a referent to encode various possible power-relations- the individual viewer need only occupy the boulevard-space, with movement along the perspectival network only confirming the relations of the urban system as visible from a single point.

1.3. THE PARKWAY AND THE SYNTHETIC FRAME

The use of a new and larger scale in town planning which would coincide with the scale already being used in the parkway system is an imperative necessity for the salvation of the city. ... It is closely connected with the space-time conception of our period (Giedion 1949, 633).

The new scale of development necessitated and facilitated by industrialization of the city renders the static frames of medieval clotted urban space or Renaissance perspectival space insufficient for contemporary urban comprehension. The examples that Giedion used to illustrate the change in the relationship between the perceiving subject and the large scale of the industrialized urban environment are the Parkway and Rockefeller Center. Meant to be occupied only within a moving automobile, and facilitating rapid movement through the city, the spatial system of the Parkway cannot be comprehended from any single point, and offers little comprehension of the surrounding environment to which it provides a means of access. Understanding how to navigate a city using the networks created to facilitate mechanized transportation- whether automobile or train, possibly plane- requires movement and memory, calling for the individual to organize, categorize and prioritize sensory information. No one image or spatial figure can be guaranteed to sum up the industrialized urban environment. A dynamic, synthetic frame of reference is necessary.

Artists were the first to find ways to cope with the alienation of their rapidly industrializing environment. The Cubists found some measure of expressive solace by breaking the single picture plane to depict spatio-temporal simultaneity. Soon, architects like Le Corbusier, who first participated in the development of the dynamic/synthetic frame in the realm of painting, were able to apply transparency and spatio-temporal simultaneity to the built environment. Giedion finds that contemporary, large-scale developments like Rockefeller Center utilize the dynamic frame in their approach to ordering the space of the city- Rockefeller's pinwheel configuration offers varied and sometimes contradictory spatial arrangements and hierarchies to the occupant- creating an urban space that is consistent with the space-time of industrial society.

[N]othing of the essential character of an organism like Rockefeller Center is revealed in a view restricted to its central axis. It possesses symmetries which are senseless in reference to the aesthetic significance of the whole. It requires comprehension in space and time more closely analogous to what has been achieved in modern scientific research and in modern painting (Giedion 1949, 642).

2. EXPERIMENTS IN DYNAMIC FRAMING

2.1. PAVILLON DE L'ESPRIT NOUVEAU

Le Corbusier's *Pavillon de l'Esprit Nouveau* of 1924-5, like Rockefeller Center, was an experiment in synthetic space-time. Le Corbusier's deployment of the contents for this exhibit at the Paris *Exposition Internationale des Arts Décoratifs et Industriels Modernes* shows a self-conscious use of space in the format of the presentation. The exhibit's parti was composed of two distinct sections, a circular, drum-like space containing a presentation of the *Contemporary City for Three Million Inhabitants* and the *Plan Voisin* for the center of Paris, and a cubic volume comprising a single prototype dwelling for the context of the larger contemporary city (Benton, Louis, and Phaidon 2008). Moving back and forth between these two spaces required the occupant to construct a synthetic frame to contain memories of the exhibition materials within a single, comprehensible conceptual structure. This synthetic frame would hold a trans-scalar vision of modernism as a methodology for creating the individual dwellings, the buildings that contain them, and the city that would form their larger context.

Only focusing on the model and drawings of the *Plan Voisin* in the drum-volume of the *Pavillon* obscures the movement implied in the exhibit's *parti*, and thus hides the creative synthesis of spatial comprehension that such an exhibit includes. The frame that encompasses the modernity presented must be held in the mind of a moving viewer. This formula of ocular sensation combined with movement in space was mentioned numerous times by Le Corbusier in his writings, and it has been analyzed in various ways by historians and theorists, and is an integral component of the famous *promenade architecturale* (Jencks 2000). Le Corbusier utilized the *promenade architecturale* to dramatic effect in the *Maison La Roche Jeanneret* of 1925, the same year as the *Pavillon*. Is it much

of a stretch to see this spatial organizer in the contemporaneous exhibit, to see spatial movement as an information organizer that provided a context for discrete materials in various scales and formats?

The question that arises from observing the role of movement in the *Pavillon* is how are we to interpret Le Corbusier's urban forms? What are grids and functional zones, segregated modes of transportation, and repetitive super blocks when considered within the heteroclitite, synthetic frame of the moving subject? For posterity, left only with publications, the dual character of the interpretable values presents a dilemma. Does one favour the didactic clarity of the perspectives and plans, the compartmented exposition of urbanity indicated by the *Athens Charter*, or does one's focus shift rather to the aberrant materials with fractured formats that show the author's desire to present urbanism with the variety and complexity with which cities are experienced and comprehended? In making a working value decision, one should recognize that the profound linkage between movement, organization and cognition would emerge in increasingly intense examples as Le Corbusier's career continued beyond the *Pavillon*. Presented with a dilemma offering alternatives of clarity of through reified concepts presented discursively and the complexity of interpreting the built environment, Corbu's publications show an obsession with the possibility of slipping between the dilemma's horns with consistent attempts to invent methods that conflate the didactic clarity of totalizing frames with the obscurities of image, movement, and space.

2.2. POST-PAVILLON EXPERIMENTS

In *Précisions*, Le Corbusier documented the contents of his 1929 South American lecture tour. To introduce and provide a context for the material in the lectures, Corbu utilized the format of the travel journal to present the aberrant cultural musings of "The American Prologue", where his first airplane flight became a topic generator, organizing adjacencies between disparate thoughts and observations (Le Corbusier 1930). He deemed the combination of flight and observation sufficient to organize the information in this short text. Several years later, Corbu used the dynamic frame induced by combining eyes that see and movement through space as an organizer of urban information obtained during his 1935 North American lecture tour, published as *When the Cathedrals Were White* (Le Corbusier 1937). The content of this book is decidedly urban, but nowhere to be found is the single, totalizing point of view of the urban plan, the static frame seen in the perspectives and plans so frequently culled from the *Œuvre Complète* (Le Corbusier & Jeanneret 1991). In 1924 when Le Corbusier wrote *Urbanisme*, he used Manhattan as an example of progressive urbanism- praised for its intensive and boldness, derided for its chaos (Le Corbusier 1924). But, after finally visiting Manhattan nearly a decade later, Corbu presented his thoughts of American cities in *Cathedrals* by foregoing didactic explication and analysis altogether. Instead, he presented American cities through the subjective events of a travel diary. Here, the format of the "American Prologue" is used for the *entire* work; crossing the George Washington Bridge, seeing Louis Armstrong play in a jazz club, encountering the statue of George Washington deep in the financial district, train rides through the suburbs- these experiences and the affective relations they gather, scattered thoughts they stir, become an urban analytical framework.

When the *Cathedrals Were White* is certainly unusual, but it can be considered as a companion publication linked with the *Athens Charter* (CIAM 1938) or *La Ville Radieuse* (Le Corbusier 1935) to form a set describing an urbanism that can encompass a great variety of material. Certainly, a great deal of conceptual work is required of the reader to construct a framework dynamic enough to cover the variations and contradictions contained in this set, and the synthetic frame constructed would be as much a product of the individual receiver as the original publications. But this individual, subjective agency is not fundamentally different from the requirements demanded of the viewer by the complex spaces of Le Corbusier's paintings, and the material considered is only as diverse as his architecture. Constructing a single frame explaining a continuous imperative of architectural invention was important for Corb-scholars whose work centered on producing discursive systems guiding value and interpretation (Jencks 2000; Tzonis 2001; Curtis 1986). Linking later, expressive works like the chapel at Ronchamp and the *Unité d'Habitation at Marseilles* with the early modern villas of the 1920's can obtain an image of Le Corbusier as an architect that is useful for applying historical precedents to the complex problems of contemporary architectural practice. Constructing

the synthetic frame that can include the idiosyncrasies of *Précisions*, *Cathedrals*, the *Pavillon*, as well as the iconic renderings of the *Ville Radieuse*, the *Plan Voisin*, and the obtuse tenets of the *Athens Charter*, could yield useful material for urban problem solving without necessarily being an apologist or revisionist by ignoring the obvious problems and contradictions of these works.

Culmination of the dynamic frame as an experimental format in Le Corbusier's work can be seen in his *Poem of the Right Angle* (Le Corbusier 1955). Here, the viewer is painfully aware that the simple diagram of the work, the rectilinear *iconostase*, is didactic but does not immediately reveal all of its secrets. The structure and interrelation of elements in the poem are multifarious and incredibly rich, yet Le Corbusier has no qualms in representing the general structure in a simple, gridded format. The motifs in the paintings indexed by each cell of the iconostase are ordered or linked by axis, adjacency, boustrophedon (serpentine movement) and three dimensional spiralling. This late work can offer interpreters a clue to envisioning grids and zones with a dynamic frame, as here rectilinear repetition is a foil or breeding ground for variety and complexity, and not an attempt to reduce or eliminate heterogeneous conditions.

The *iconostase* reveals that Le Corbusier did not see the grid as a restrictive ordering device. Didactic clarity in Corbu's works always exists simultaneously with contradiction and variety. So, what history is told beyond the didactic plans and renderings with their totalizing frames and continuous, homogeneous spaces? The repetitive, rectilinear geometries of the different parts of Le Corbusier's city plans, whether dealing with housing or administrative zones, offer both didactic clarity of ordered unity and a great deal of variety to the occupant strolling along the meandering footpaths at the feet of the buildings. *The City for Three Million Inhabitants*, the *Radiant City*, the *Plan Voisin*, etc, would not look the same from the ground as they do from the air. Reading the content organized by simple rectilinear geometries in these designs in the same way that Corbu called on the reader to use the *iconostase* reveals opportunities for unexpected adjacencies and emergences within the rigorous logic of the plan.

3. CONCLUSION

3.1. PROLIFERATION OF FIGURES

Indicated in Giedion's three space-time figures is an attempt to found a new kind of historical analysis to establish meaningful relationships with modernism in architecture and an urbanism for industrialized society. Giedion's own later development of the figures into analytical categories- the "three space conceptions in architecture": architecture as space-radiating volumes; architecture as interior space; architecture as both volume and interior space (Giedion 1971), lost the evocative power of the original space-time figures as a theoretical organizer. Unlike his project to outline architecture's three space conceptions, Giedion's original three figures from the 1930's do not appear to be a complete inventory of space-time conditions. New figures can be conceived and added to the list to increase the inventory of existing or possible urban space-time configurations. Le Corbusier's series of works utilizing the dynamic frame of a prescient subject engaged in physical movement can be seen as attempts to develop new space-time figures for understanding contemporary urban conditions. While Giedion hazarded the parkway figure to describe the new scale of the industrialized city, Le Corbusier continued to produce new experimental figures, consistently enriching his spatial conceptions as the continued march of the twentieth century brought new conditions into confrontation with the existing stock of concepts used to understand them. Analyzing Le Corbusier's urbanisms using the concept of the space-time figure provides a research framework as dynamic as the inventive efforts of these modernist proposals.

From the discussion above, the *Pavillon de l'Esprit Nouveau* might be said to have a space-time figure of trans-scalar synthesis, with a nestling of solutions at various scales. This trans-scalar figure is similar to the relation of figures in Le Corbusier's contemporary Purist paintings, a multiple and sometimes contradictory space formed synthetically by the observer to encompass the material presented. The "American Prologue" of 1929-30 presents the figure of air-travel, an urban space-time that Corbu finds terrifying and fascinating. We should not confuse this figure with that of the bird's-eye-view or the celestial view, which has been a prevalent guide for formal urban developments around the

world for millennia. The prologue's figure is not hypothetical but physical, the moving view-point of a human eye positioned amongst the clouds. The tumult of rapidly changing natural conditions and a sense of the overwhelming scale and power of the natural world made the formal concerns of city planners seem futile, the tiny cities below dwarfed by the immensity of the Amazon. Corbu was overwhelmed by a geological and vegetal space-time during this first flight. Instead of reinforcing the static vision of a God positioned outside of earthly space and time, air-flight was an experience that led Corbu to muse over revolution, war, and radical change (Le Corbusier 1930), a fully historical time and material space, inevitably subjected to change.

Just as the flight-figure of the "American Prologue" supports alternative conceptual material than the figure of the idealized bird's-eye-view, analyzing the Athens Charter drafted by CIAM in 1933 using the framework of proliferating, experimental space-time figures yields surprising results. Perhaps the simplest figure to posit for the Charter is one of swathe-zoning, where a fully abstracted and homogenized logical space is allowed to assert a rigorous system with little influence from the perceiving subject. Time is a component of the swathe-figure only as a modulator of scale-proximities and adjacencies of zones are regulated by the 24-hour day and the speed of inhabitants' necessary movements as they go about their day. Thus, a trans-scalar adaptability is implicated in the swathe figure, recalling the diverse propositions of the *Pavillon de l'Esprit Nouveau*. Including time in the *Charter's* figure references a cognizance of users' needs that is lacking in many urban plans that were developed using the concept of swathe zoning.

When the Cathedrals Were White presents an urban space-time of affective events that Corbu had previously called "radiant moments" (Le Corbusier 1935; 1964, 129). As discussed above, *Cathedrals* is structured around a series of these radiant moments, fully subjective and embedded in the immediacy of urban experience and cognition. The unusual radiant-moment figure used to present the contemporary built environment of the U.S. explains the frustrating lack of exposition or sound argument in this publication. That this publication is not a total mistake on the part of the author, but is rather a component of an experimental series of experiments in urban representation and comprehension is supported by the appearance of the *Poem of the Right Angle* in 1955. An awesome and captivating work in its physical size and the syncretic nature of its contents, the *Poem* could be understood as a compendium of sorts, an index of space-time figuration, as understood late in the life of its creator.

Maybe it is merely the novelty of Giedion's figures that makes them compelling. But the brief account of urban space-time figures presented here is certainly an inquiry into the invention of Le Corbusier's urbanisms. The figural account is a nascent history, as was Herodotus' *Inquiries* into the origins of the Greco-Persian Wars of the 5th century BC, which although unusual at the time, would become a foundation for historical conventions (Walter 1992, 18). Traditional historical analysis blends subject and object, diachronic and synchronic analyses, word and image, idea and experience, but it does so with an apparatus of conceptual tools that has become habitual to the point of perceived transparency, appearing to be logical. The novelty of the figural history that Giedion proposed in the 1930's should not obfuscate its utility in conveying some of the difficult and forgotten stories in the development of an industrialized society that continues to change and challenge the urban subject.

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Integrating geometry and light: daylight solutions through performance-based algorithms

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ABSTRACT:

Designing spaces for daylight is a complex problem for architects, balancing geometry with the location of daylight sources. Conventional design practice approaches this balance one-dimensionally: common procedures, rules of thumb, and building codes lead designers to default to regularity when designing windows and skylights.

The problem of daylight can be restated, starting first from the basic performance goal of distributed, uniform light. In traditional vernacular architecture, it is common to observe intentional coincidences among windows and interior surfaces, illustrating that openings and interior geometry can be integrated to distribute light in a way that is also experientially dynamic: integration also understood by great architects of the past and present.

Parametric design – a method of working where pieces of a simulated model can be manipulated ad infinitum – provides a new way of studying the relationship between light and geometry in the producing desirable, uniform, lighting conditions. Taking parametric design a step further, it is possible to tie together parametric models and computer-based simulations to produce an algorithm that ‘finds’ optimal configurations between openings and interior geometry. Such an algorithm reveals two possibilities. The first is that designers can systematically determine the best relationship among openings and interior space. Secondly, the success of these algorithms offers objective proof that, in comparison to the default of regularized patterns of openings, a more organic (i.e. less artificially ordered) relationship between openings and interior indeed is better for producing uniform daylight.

Two parametric algorithms will be discussed in the paper: an optimization algorithm, leading to a given problem to a single solution, and an evolutionary algorithm, using the random generation of individual solutions to reach better fitting results. The workings of the algorithms as well as the interpretation of the results in the context of design for daylight are discussed.

CONFERENCE THEME: Approaches: Digital and the Real World

KEYWORDS: Computing, Parametric, Optimization, Algorithm, Daylight,

I. INTRODUCTION

Designing spaces for natural light is a complex problem for architects, involving the balance of surface geometry with the size, proportion, and location of daylight sources to produce uniform, balanced light (Fig. 1). Yet the one-dimensional procedures, narrow-sighted rules of thumb, and building codes informing conventional practice lead architects to favor centered, repeating, symmetrical, and other uniform solutions for openings. Driven by intuition and a trial and error process, designers default to regularized solutions that overlook the problems and opportunities that can stem from a more precise understanding of interior daylight and its experiential dimension.

The hypothesis of the paper challenges conventional daylight design on two levels: summarizing some important problems with the conventions, while also posing a method for developing optimized solutions to daylight that can be applied without the conventions, using computer-based parametric modeling, simulation, and algorithms. The importance of deriving a solution from three-dimensional geometry is that the results are based upon the actual, three-dimensional relationships between the sky, the interior surfaces, and the plane of analysis. Geometry in this case is actually critical, in contrast with the flattened derivations of buildings and rooms as in traditional daylight calculation methods, or the one-dimensional glazing percentages often used during schematic design.



Fig. 1: In the lobby of the Canadian War Museum, designed by Moriヤマ + Teshima Architects, light from above is reflected by canted walls, resulting in complex interplay between direct and reflected light. (Source: Author)

2. CURRENT DAYLIGHT DESIGN PRACTICES

2.1. PREDICTING IDEAL DAYLIGHT CONDITIONS

Ideal daylight conditions may be defined in part by adequate illuminance, or light volume, for a given task. Secondly, ideal lighting conditions must also consider luminance, or the amount of light reflecting from surfaces; spaces with a large amount of luminance or a large degree of variation in luminance within the visual field can result in the undesirable condition of glare (Rea 2000).

Estimating the performance of daylighting schemes involves the estimation of the amount of light volume in the space contributed by the sky and other external sources. Using daylight factor analysis, a 'daylight factor' for a given position in an interior space can be computed using a uniformly luminous sky that is roughly equivalent to an overcast sky. The value for daylight factor in a given location is a percentage of interior illuminance relative to exterior illuminance, taking into account contributions from interior and exterior reflected light (also referred to as reflectance) as well as light contributed by the sky (also referred to as sky factor).

Methodologies used to calculate daylight factor across a given space have been in place throughout the 20th century. Prior to powerful computers, designers and engineers used primarily two methods to predict daylight performance: using scaled, two-dimensional drawings to draft geometrical relationship between the exterior sky and interior surfaces, and later, using scale models with small light meters. It is likely that in many cases, the tedium of these methods discouraged complex solutions in favor of solutions with more neutrality – i.e. windows and skylights centered in rooms. Model-based solutions were useful for addressing reflected light on interior surfaces, but the use of reflected light in geometry specific daylight strategies – using light shelves, reflective coatings, etc. – was not a widespread practice.

2.2. THE WINDOW PLACEMENT PROBLEM

The architectural theorist Bruno Zevi addresses the issue of window placement by asserting that light should come from "[a]nywhere, as long as it is not in the center of a wall, dividing the room into three sections, an illuminated one between two areas of darkness. Let us give each window new

meaning as a specific light carrier in function of the interior space (Zevi 1978).” Zevi clearly connects the placement of the window with its effect on three-dimensional space – something that could not be easily provided by methods of the past that ignore three-dimensional light and surface interaction. A computer simulation can quickly demonstrate the unfortunate shadows that Zevi predicts from a room-centered window (Fig. 2) and the better results produced from an elongated window that washes adjacent ceiling and wall surfaces with light (Fig. 3).

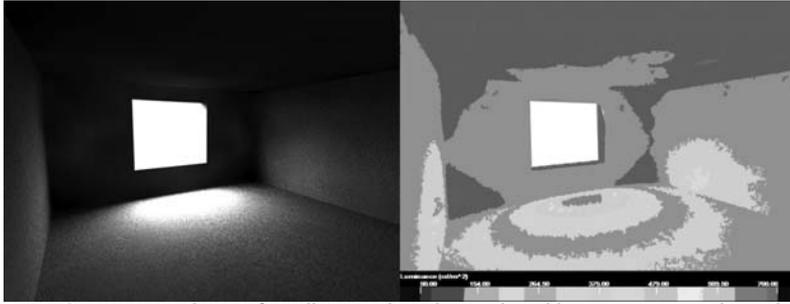


Fig 2: Computer simulation of a wall-centered window, with problematic contrast and poor light distribution; note luminance ranges in the field of view between approx.50 and 700...a serious contrast problem. (3DStudio Max radiosity rendering engine with IES diffuse skylight – typical for subsequent visible light renderings and luminance studies) (Source: Author)

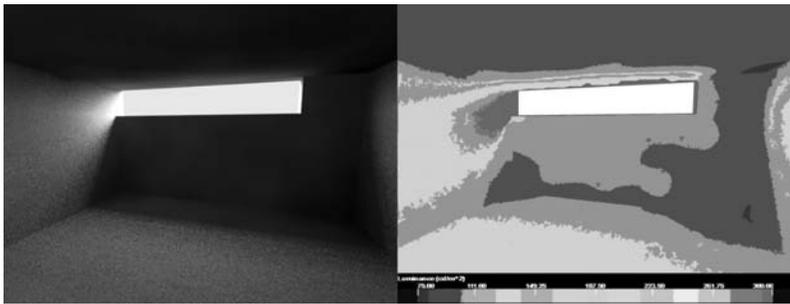


Fig 3: Better results are observed from a window whose light reflects on adjacent wall and ceiling surfaces. Discussed later: given the results of a particular simulation, how does one determine which variables to explore? Should position or proportion be changed first in this example? (Source: Author)

Computer simulation, as shown in Figures 2 and 3, provides performance feedback that is geometry-specific and as a result a powerful design tool. Yet recently and even newly built buildings show that architects still ‘yield’ to inane façade ordering systems and the convenience of symmetry (Fig. 4). Why do architects still produce these ‘yield solutions’, even if this placement compromises the distribution of light? A few historical anecdotes may explain. In the western tradition of architecture and specifically in urban buildings, the window was an important component of a façade and its position was dictated more by the exterior composition, the masonry construction methods prevailing in urban areas, and avoidance in interfering with electric illumination (of all things).

The arrival of the curtain wall and fully-glazed buildings in the twentieth century further distorted the notion of daylighting. Fully-glazed buildings pose two serious environmental control issues: the huge amount of heat loss and heat gain through the envelope, and a large volume of light at the perimeter of the building contrasted against a relatively dark interior. Decades of dealing with these two issues leave a set of codes and practices that have further reduced daylight design to one-dimensional solutions.



Fig 4: Common 'yield' window placement, with openings carelessly arranged with preference to exterior appearance. (Source: Author)

For example, current lighting standards (ASHRAE/IESNA Standard 90.1.2007 is the standard, and is also referenced by LEED) provides prescriptive limits on glazed areas for walls at 50% of exterior wall surface area, and for roofs at 5% of exterior roof surface area for the purposed of conserving energy. Regulating glazing in this manner makes sense for controlling thermal performance of the envelope, but says very little about the role of glazing as a daylight source. Such thinking suggests a building designed by a spreadsheet. The same lighting standard deals with lighting distribution, including both artificial and natural lighting, in terms of lighting power density. Lighting power density is expressed in bizarre units of Watts per square foot, a deference to the calculations for heating, ventilation, and cooling calculations that are impacted by the waste heat of artificial lighting. Without entering into a lengthy technical discussion, it may be summed up that the ASHRAE/IESNA standards dictate that artificial lighting is addressed first and daylight introduced afterwards for the sake of energy conservation. It may also be argued that buildings should be designed for artificial light because at night and on particularly gloomy days, artificial light is a necessity. (ASHRAE)

Yet these standards mentioned above, along with other prescribed strategies such as those related to ceiling height and floor proportioning, provide little inspiration for the design of day light features and their relationship to space. What is inevitable in this thinking is that windows and openings are reduced to uniform and static features, just like the grid-born artificial lighting that the windows supplement.

2.3. INTEGRATING GEOMETRY AND LIGHT

Well-known contemporary architects have demonstrated the importance of interior geometry to daylight. Concepts of daylight show up frequently in the work of Frank Lloyd Wright, and in his essays in *The Future of Architecture*, Wright the notion of daylight, light screens, and the relationship between light and surface are the underpinnings of three of the nine 'motives' (Wright 1953). Bruno Zevi wrote of this light-surface integration in Wright's prairie houses, where "every detail and moulding is conceived to receive, grasp, transform and transmit light (see Fig. 5). (Zevi 1991)

Corbusier, who clearly worked in a separate design and theory camp than Wright, also understood

this close association between light and geometry, writing in *Towards a New Architecture* “[t]o erect well-lit walls is to establish the architectural elements of the interior” (Le Corbusier 1927). In the work of many recent master architects, including Eero Saarinen, Alvar Aalto, Steven Holl, Louis Kahn, Renzo Piano, and many others too numerous to mention, this connection between daylight and interior surface is a defining feature – although other seductive qualities in their work may eclipse the thoughtful positioning of openings relative to surfaces (Fig. 1).

On the other hand, coordinated daylight and interior surface can be recognized even in traditional vernacular dwellings (as opposed to the façade-dominated urban buildings mentioned earlier), where interior features such as walls, window jambs, floors, and ceilings are assembled to reflect and distribute light (Fig. 6). From vernacular to modern design, thoughtful daylighting is more than just an environment adequate for tasks, but an environment beneficial to its inhabitants. Clearly the simple problem of positioning a window in a room calls for more sophisticated strategy of design that considers the interaction between light and surface.



Fig. 5: Frank Lloyd Wright’s prairie style interiors often exhibited windows at the corners of the rooms or positioned against walls, in order to use interior surfaces to reflect light. (Wescott House designed by Frank Lloyd Wright) (Source: Author)



Fig. 6: Vernacular dwellings typically positioned windows carefully to bring light to task areas and close to walls where it could be reflected (Shaker common residence, Canterbury, NH) (Source: Author)

3. SIMULATING DAYLIGHT: NEW COMPUTING METHODS

3.1. ADDRESSING PERFORMANCE WITH COMPUTER SIMULATION AND PARAMETRIC COMPUTING

Fine-tuning surface and light relationships in the past involved cumbersome methods, and has not been encouraged by standards and codes. Yet today's computer-based analysis gives designers the capability of creating and refining daylighting schemes that integrate surface and light.

As discussed early, computer simulations can produce analyses for daylight factor (illuminance as a percentage of exterior light) and luminance (measurements of reflected light and presence of glare); moreover, these models can simulate and subsequently test specific three-dimensional features in a daylighting scheme, including features like light shelves and clerestory windows. In doing so, we can develop solutions that, recalling the words of Zevi once again, "give each window new meaning as a specific light carrier in function of the interior space." (Zevi 1978)

To illustrate a method-based application of computer-based lighting analysis in design, a single simulation is not enough; instead we must run many solutions. Connecting performance with design implies that a designer seeks to optimize (i.e. make as high-performing as possible) a given design. To do this, designers must not only test their design, but apply a method for subsequently improving their design, in order to test it once again. Computer-based lighting analysis is particularly useful here, because testing a given iteration of a design is relatively painless, perhaps consuming a matter of minutes or even less to produce data. To apply a systematic approach, a designer may proceed using simple heuristic methods, perhaps using explicitly determined variations of a design to determine which is best in moving towards a desired criteria.

Computing's ability to provide a multitude of simulations in a short period of time brings up two issues. One is that manually-calculated lighting analysis was limited to a small number of iterations that can merely approach optimum; with a very large number of iterations, a truly optimum or very near optimum solution is reasonable. Secondly, the notion of a model that is constantly adjusted in response to performance outcomes is suggestive of an emerging area of computing called parametric modelling. In a parametric model, the model geometry is actually mutable and tied together by equations or object-based relationships, rather than fixed points in space. Parametric models can be easily changed without being rebuilt, and can in fact be driven by performance data so that the modification of the model is more or less automated.

3.2. ALGORITHMS AND EVOLUTIONARY COMPUTING

Consider the problem of a window in a room and assume that it does not belong in the center, but somewhere on a single wall. The room and the window areas are given in this example, but the window location and proportions (length and width) are flexible. Using trial-and-error methods and computer simulation, one can move through a quick succession of computer models yet problems emerge. When something goes well in the simulation, how is it determined that window location or proportion contributed to the success? Are the two variables in the problem interfering with one another somehow? Proportion and position are two variables that, in parallel, have an organic effect on daylight that is challenging to pin down with intuition and manual manipulation of the design (see Fig. 3).

Yet the data provides a link between the two variables if it is 'read' in a way that isolates patterns indicating the effect of window position and proportioning. While we can look at the graphic outputs from our analysis, we can also use statistics and data processing to look for these patterns and use them to inform changes made to the model. The idea that data can be used to drive design decisions is somewhat of a sacrilege in architecture, but has been common practice in engineering, even before modern computers.

Humans can certainly interpret data, but we can also connect the data to our parametric model to complete a sort of feedback loop where data directly triggers changes in the model. As a result of this directness, non-rational interference (aesthetics, whimsy, etc.) is suppressed and the path through several iterations should, theoretically, lead to an optimized solution, where the feedback

loop would actually slow down or stop as its criteria become satisfied. In the computing world, such a computing device is known as an 'evolutionary algorithm' (falling into the category of evolutionary computing) because its solutions are evolved towards optimization. The connotation of 'evolve' in this case is interesting; it suggests a sort of hands-off approach to problem solving, in which a solution is developed from the algorithm without intervention – at times producing unexpected results. The latter is termed 'emergence,' a phenomenon where the solution, unpredicted at the beginning, emerges as the algorithm unfolds.

4. DEVELOPING DAYLIGHT SOLUTIONS USING EVOLUTIONARY COMPUTING

4.1. APPLYING EVOLUTIONARY PROGRAMMING

Before further discussion of evolutionary computing and daylight, a method for evaluating and processing the simulation data must be recognized. Recall that uniform, glare-minimized (low contrast) daylight conditions are considered ideal. The IESNA Lighting Handbook notes that an ideally lit environment has uniform light distribution in the visual field (i.e. free of glare) and is covered by light sources of similar intensity (Rea 2000); from this definition, we may extrapolate that designs optimized for daylight factor should exhibit a consistency in daylight factor data throughout the analysis area.

Previous research by other parties has identified statistical standard deviation as a useful metric in assessing lighting consistency and thus minimization of glare (Demers 2007). By assessing the standard deviation of daylight values, the degree of variance across the analysis area is quantified and the degree of uniformity in light distribution is represented. Light distribution, in this case, is now a statistical value: a useful complement to the daylight factor contours typically produced by lighting simulations. Now each of the iterations within the modeling algorithm can be objectively compared using standard deviation, while daylight contours provide an additional visual aide.

Returning to the issue of evolutionary computing, the experiments carried out and presented in this paper fit into two classes of evolutionary problem solving: the first is an optimization algorithm, applied to a window and skylight coordination problem, and the second is an evolutionary algorithm, applied to a distribution problem involving multiple apertures on walls and the ceiling. Each approach is different, with different approaches tying together data and parametric models in a feedback-based algorithm. In the endnotes of this paper, a few technical points are discussed that address limitations of the algorithms.

4.2. OPTIMIZATION ALGORITHM: SKYLIGHT AND WINDOW

The optimization algorithm discussed in this research was developed to optimize the position and proportion of a skylight in a room containing a single window; the window's position was off-axis and in particular, resulted in an initial condition where one area of the room had a high concentration of daylight in contrast to the rest of the room. An optimization algorithm is a problem solving algorithm that iteratively cycles through a set of input and output operations that shifts in the model incrementally, rather than all at once, towards a solution (Papalambros 1988). The problem at hand involving the window and the skylight is particularly suited to this sort of algorithm because it has a single variable, and the final solution is difficult to solve intuitively. Fixing the position of the window also creates a light distribution pattern that can only be balanced with a single solution, rather than many possible solutions.

In short, the algorithm operates by handing off simulation data to a spreadsheet, which produces a series of outputs that are passed back into the parametric model to drive changes to the openings parameters for position and proportion. The resultant model is used to generate a new solution, and so on. This process continues until a terminal condition is noted; in the case of this experiment, a terminal condition would occur when light uniformity (standard deviation) is fully optimized (no further improvements conceivable). Typical of an optimization problem, the parametric model, the programming it contains, and the criteria used to drive the model all must be carefully defined in order for the algorithm to work properly (Eiben 2003).

As the algorithm reaches a terminal point, optimization is manifest not as a 'perfect' solution but a cycling in the general area of a solution (Papalambros 1988), sometimes even oscillating through a series of repeating solutions, all of which are close to optimized. An indicator that an optimization has been successful is that it demonstrates 'convergence,' where two independent optimization runs from two arbitrary starting points result in reasonably similar results (Papalambros 1988). Diagrams overlaying the path of solutions towards optimization are shown in Fig. 7; in these diagrams, two different starting points are shown to converge at a similar solution. It may be noted that while the statistical outputs in the algorithm became essentially the same between these two solutions, a slight difference in position between the two solutions resulted. This difference can be attributed to the relatively low number of data points in the analysis grid that, when processed, satisfy the optimization criteria in the same way.

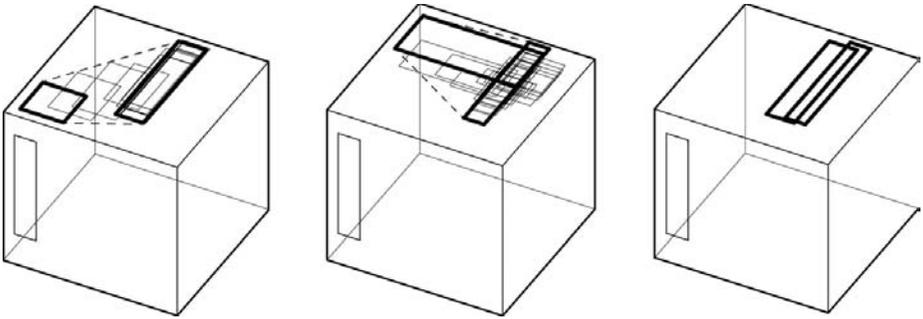


Fig. 7: Diagrams of the optimization algorithm, overlaying solutions that lead to an optimization; note that these two examples originated from different starting points yet converged at a similar solution, demonstrating convergence. The diagram on the far right overlays the two final solutions to show their similarity. (Source: Author)

Development of the optimization algorithm involved the application of three different pieces of software.

The parametric model itself was created using Rhino CADD software equipped with the plug-in Grasshopper, which enables the Rhino model to be 'parameterized' and also allows for a script (discussed later in this section) to be integrated into the model.

A program called Ecotect, a product of Autodesk, was used to calculate daylight factor for each model; the data generated in Ecotect is typically used only within the software to create a graphic display of the values as contours, graphs, etc. and may also be used to extract simple averages and extremes from the data.

The second stage of the algorithm involves processing the data from daylight analysis into outputs useful once again in the parametric model. This processing was carried out using a Microsoft Excel spreadsheet, which carries out a number of calculations. The first is to calculate the standard deviation for the data set to provide an objective assessment of the entire set of data points. The second set of calculations is more complex, and involved developing outputs that are useful in driving the parametric computer model.

In order to drive *positioning* of the skylight, the data was divided into quadrants, and each quadrant was averaged to produce a variable (Fig. 8). A higher average value in a particular quadrant could, as a result, drive the skylight to move away from that quadrant a particular amount proportional to the discrepancy in average value.

A second division of the data was made in order to drive *proportioning* of the skylight. In each direction, the middle third of the data was averaged and compared to the total average of the data; if this middle third returned a higher value than the adjacent thirds, the proportion of the skylight opening was adjusted in the opposing direction, making it 'stubbier' in that orientation. Overall,

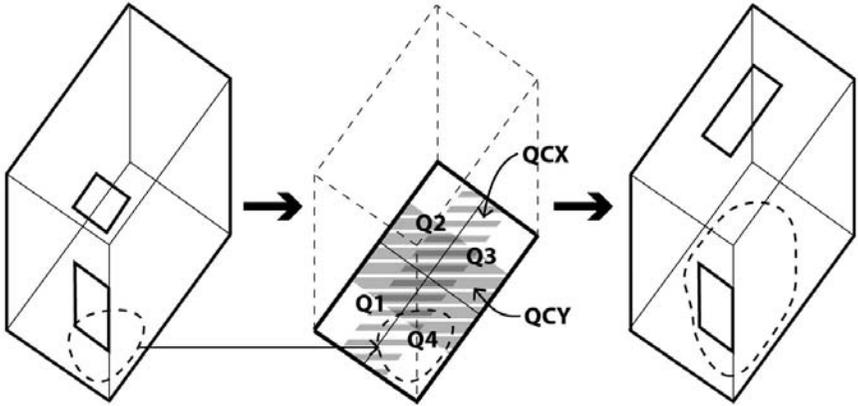


Fig. 8: Diagram of the initial optimization model, the quadrants used to evaluate the data, and the final outcome. (Source: Author)

the processing of data in the spreadsheet yields seven different averages that are returned to the parametric computer model.

The seven average outputs from the spreadsheet, upon return to the parametric model, are processed in a piece of Visual Basic computing code. The code contains a series of if-then conditional statements that function as decision-makers that are then returned into the flow of the parametric model (Fig. 9).

In summary, with every pass of the model, the model is sent to Ecotect, the resulting data moves to the spreadsheet, the spreadsheet outputs go back into the model, and a new model iteration is generated. Following this process over several iterations yields an optimized position for the skylight relative to the window (see Figs. 10-12). Additionally, the algorithm was tested using various room dimensions and proportions, some especially difficult to guess where exactly the ideal skylight position would occur. In each case, the algorithm proved successful in reaching an optimized solution (Fig. 13).

```

dblAVEQ234 = (dblQ2 + dblQ3 + dblQ4) / 3
dblAVEQ134 = (dblQ1 + dblQ3 + dblQ4) / 3
dblAVEQ124 = (dblQ1 + dblQ2 + dblQ4) / 3
dblAVEQ123 = (dblQ1 + dblQ2 + dblQ3) / 3
dblAVEQ1234 = (dblQ1 + dblQ2 + dblQ3 + dblQ4) / 4
If dblQ1 > dblAVEQ234 Then dblMVDISTQ4 = ((dblQ1 / dblAVEQ234)) * dblMVFCTR
If dblQ2 > dblAVEQ134 Then dblMVDISTQ3 = ((dblQ2 / dblAVEQ134)) * dblMVFCTR
If dblQ3 > dblAVEQ124 Then dblMVDISTQ2 = ((dblQ3 / dblAVEQ124)) * dblMVFCTR
If dblQ4 > dblAVEQ123 Then dblMVDISTQ1 = ((dblQ4 / dblAVEQ123)) * dblMVFCTR
If dblQCY > (dblAVEQ1234 * dblGRWTHRSHD) Then dblGRWY = dblGRWSCL
If dblQCY < (dblAVEQ1234 * dblGRWTHRSHD) Then dblGRWY = ( 1 / dblGRWSCL)
If dblQCY > (dblAVEQ1234 * dblGRWTHRSHD) Then dblGRWX = dblGRWSCL
If dblQCY < (dblAVEQ1234 * dblGRWTHRSHD) Then dblGRWX = ( 1 / dblGRWSCL)
If dblAVEQ1234 > dblAVEDFMAX Then dblGRWY = ( 1 / dblGRWSCL)
If dblAVEQ1234 > dblAVEDFMAX Then dblGRWX = ( 1 / dblGRWSCL)
If dblAVEQ1234 < dblAVEDFMAX And dblQCY > dblQCY Then dblGRWY = (dblGRWSCL * (dblQCY / dblQCY))
If dblAVEQ1234 < dblAVEDFMAX And dblQCY > dblQCY Then dblGRWX = 1
If dblAVEQ1234 < dblAVEDFMAX And dblQCY > dblQCY Then dblGRWX = (dblGRWSCL * (dblQCY / dblQCY))
If dblAVEQ1234 < dblAVEDFMAX And dblQCY > dblQCY Then dblGRWY = 1

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Fig. 9: VBasic computer code that was embedded in the parametric model and used to connect analysis outcomes with model revisions. (Source: Author)

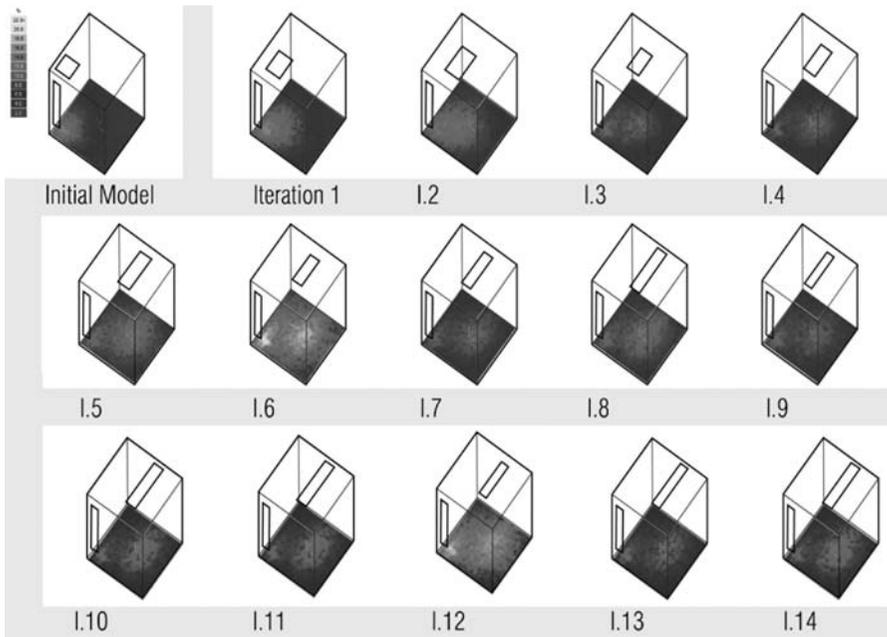


Fig. 10: Fourteen computer simulated iterations of an optimization, starting from the initial model, and showing the distribution of daylight factor values at floor level. (Source: Author)

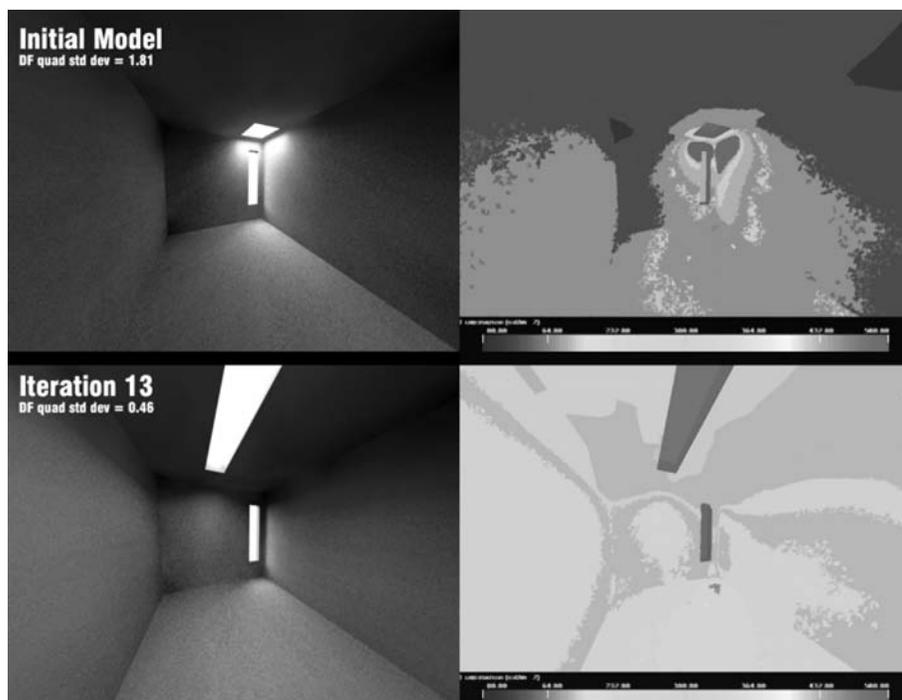


Fig. 11: Computer simulations comparing the initial model and iteration 13; note the increase uniformity of the light reaching the floor and the increase in light on the walls. (Source: Author)

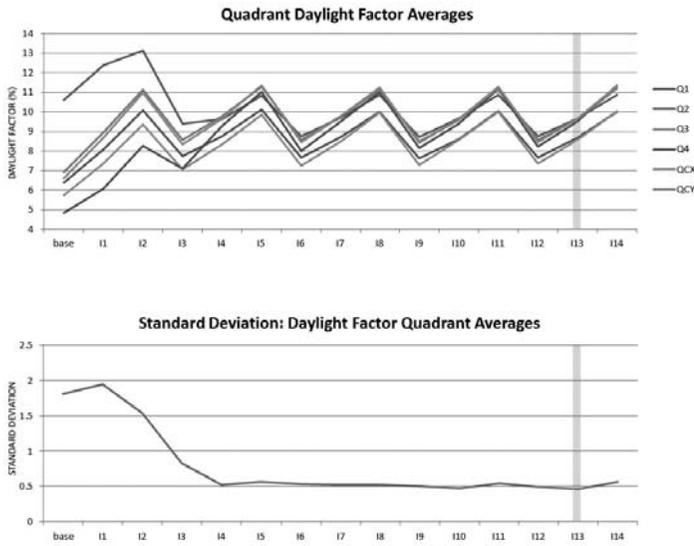


Fig. 12: Graphs showing the progress of the data during the optimization. Quickly daylight values become more uniform and cycle through high and lower average daylight factors as the parametric model reaches a prescribed limit. Iteration 13 shows the lowest standard deviation of the set, indicated it is the most uniformly lit solution of the 14. (Source: Author)

4.3. EVOLUTIONARY ALGORITHM: MULTIPLE OPENINGS

Optimization algorithms will always produce the same results given the same starting point, since outputs and performance will always lead to the same results. Evolutionary algorithms are very different, progressing in an unprogrammed manner using a process similar to that of evolution and natural selection. Based on a stochastic (in other words purely random) process these tools have the power to solve problems especially difficult for the human mind to solve.

In an evolutionary algorithm, the computing begins with an initialization of a population from randomly varying individuals who are then evaluated for fitness against a criterion (or multiple criteria), and then from these selected individuals a new population is initialized after the seeding individual's characteristics are mutated (Sivanandam 2008). After a few generations pass, surviving individuals will begin converging on characteristics that result in high fitness, or in other words, optimization around the chosen criteria for fitness.

In the research presented in this paper, an evolutionary algorithm was applied to the problem of providing uniform light from six openings (four windows and two skylights) arranged on two adjacent walls and the ceiling of a given room. The remaining two walls were left vacant of openings. Using multiple openings in this case presented a more appropriate problem for an evolutionary algorithm to solve: a single variable problem (i.e. involving one window) could be solved by human expertise or a simple linear optimization, but not a multiple variable problem (i.e. with multiple windows). An evolutionary algorithm is useful because it can assess multiple variables simultaneously in order to advance the algorithm (Sivanandam 2008), a strategy as humanly impossible as guessing a multiple digit password.

To create the evolutionary algorithm, once again a Rhino's Grasshopper plug-in was used to develop a pair of parametric models, each containing a bit of code that would randomize parameters for the openings using Visual Basic 'randomize' and 'rnd' functions in conjunction to generate a truly stochastic number within a given range.

Simply described, one model was used to initialize the first population of solutions; this model randomly scattered six openings on the assigned faces, and randomly proportioned the openings

while maintaining a defined opening area. A second model was used for generating subsequent generations from a seed solution. In this second model, the room and its original openings were the starting point, and the model randomly mutated the position and proportion of all six openings according to a given constraint.

Establishing fitness (in other words, setting criteria for the best solutions in the set) involved calculating overall standard deviation and overall average daylight factor value from the data set for each solution. The results were graphed in an X-Y graph to identify solutions whose data points, a combination of average daylight factor and standard deviation, appeared distinct from the other solutions. To generate a graph in which both standard deviation and average value numerically ascended in their axes, a mathematical inverse of standard deviation was used.

Tracking the effectiveness of the evolutionary algorithm is somewhat murky, since fitness and progress of the algorithm may be based on comparison with the original population, with the previous generation of individuals, or with the current generation of individuals. This issue is compounded when a generation produces two individuals that are highly fit for one criterion but are not successful in the other criterion. Clearly more work is needed in understanding the best application of fitness to these sorts of algorithms.

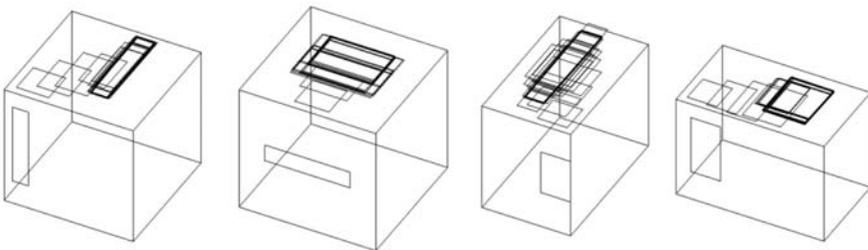


Fig. 13: Various room and window configurations tested by the optimization algorithm, and the resultant solutions. (Source: Author)

It is important to note that the evolutionary algorithm described here is not a full-blown genetic algorithm. Experts in the field of evolutionary computing are mixed on the subject of whether all evolutionary problem solving should do so, but some level of recombination or simulated reproduction (Eiben 2003): for example, combining traits from different individuals to form the next generation of solutions. More computing-intensive genetic algorithms will even use a stochastic process in the selection of individuals in order to eliminate external determinism from the process (Sivanandam 2008). True genetic algorithms, consequently, require a great deal of computing and remain beyond the scope of research presented in this paper, but intend to be explored in future research.

The results of the evolutionary algorithm experiment, though limited to only two generations due to constraints of time and programming capacity (discussed further in the endnotes), exhibit some success in increasing the performance of solutions both from generation to generation, and in comparison with the original yield solution (Figs. 14-17). On one level, the algorithm is successful in using a randomly based process to improve daylight performance in at least in one of the successive generations (the set of 13.x solutions) following the initiation set, providing evidence that the algorithm can work. Solutions in this set also performed better than the yield solution with its arbitrarily symmetrical, wall-centered openings as well. On the other hand, two of the three successive solutions that were run in parallel (21.x and 22.x sets) did not show much improvement from the seed solutions, although they still outperformed the yield case. This is a reminder that an evolutionary algorithm can certainly regress as it moves towards optimization; perhaps subsequent generations, either from the 13.x set or from the initiation set, would have performed better. It may also be possible that a better way exists to establish fitness for these solutions, something that may emerge in future research. In sum, the evolutionary algorithm verifies the hypothesis that an evolutionary

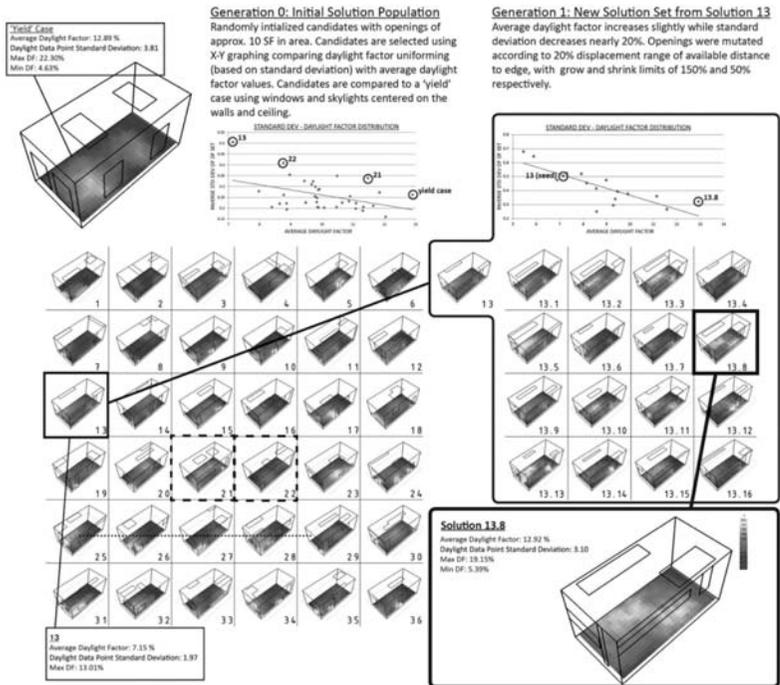


Fig. 14: The initialization population of the evolutionary algorithm, with one of the first branches shown as an example. Note the X-Y graphs synthesizing comparisons of standard deviation and average daylight factor. (Source: Author)

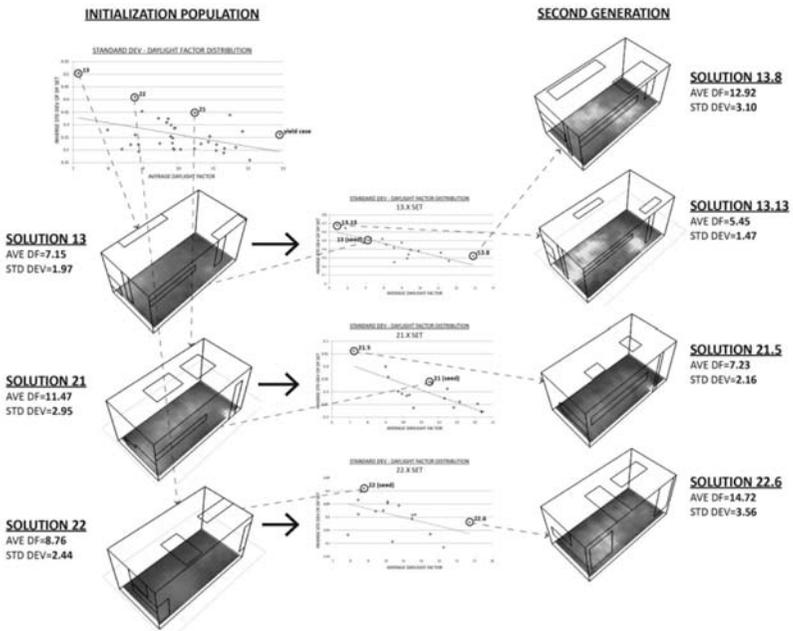


Fig. 15: Selected solutions from the evolutionary algorithm from initialization set and subsequent generation. (Source: Author)

Evolutionary Algorithm Performance Summary of Selected Solutions

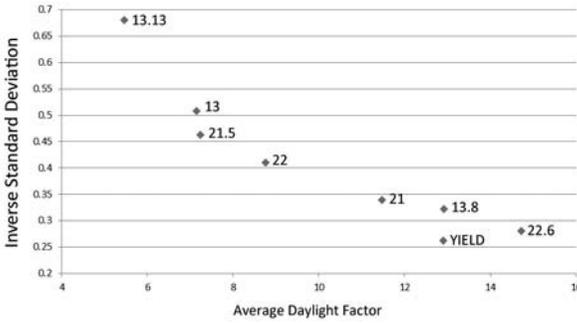


Fig. 16: X-Y graph synthesizing inverse standard deviation values and average daylight factor values for each selected solution. Note each solution outperforms the yield solution. (Source: Author)

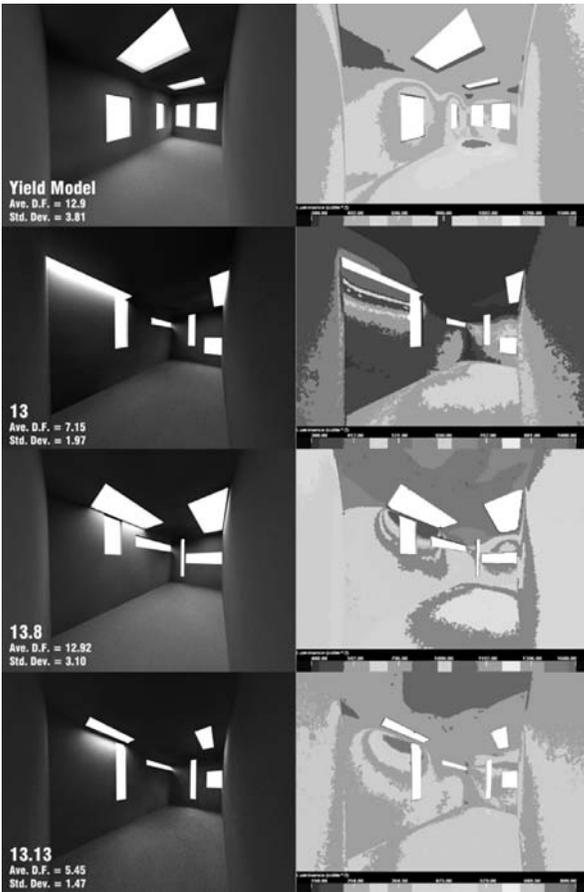


Fig. 17: Rendering and luminance studies comparing three of the selected solutions resultant from the algorithm. Note the narrowing of luminance levels into acceptable ranges and the emergence of known daylighting strategies (corner-positioned openings, high windows, etc.) in these randomly generated examples. (Source: Author)

process can be used to optimize a daylight scheme; however the potential of the algorithm as a tool at this stage is limited, and further refinement of the algorithm, the selection criteria, and the data processing is required before the real possibilities of the algorithm can be characterized.

5. CONCLUSIONS

Returning to the hypothesis of the paper, the experiments do support the assertion that the common practice of centering windows in walls results in inferior daylight performance; the optimized solutions developed by both algorithms instead positioned windows and skylights in proximity to the edges of the room. Irrespective of how much reflected light played into the analysis, it seems that placement of light sources at the perimeter of a space improves uniformity of daylight, perhaps by preventing the dark periphery that would normally occur when openings are concentrated along the middle axis of spaces. At any rate, daylight performance seems to be best when daylight is coordinated with walls. In achieving this performance-critical coordination, the algorithms presented in this paper appear to be useful strategies to serve this purpose and, in addition, strategies that are becoming more available to today's designers.

Reyner Banham called for an extension of engineering optimization beyond "acute industrial need" towards "human delight" (Banham 1984). What is of interest to me personally, as both a researcher and a designer, is that these algorithms also present evidence that daylight design is closely tied to interior space, and can be somewhat informal, providing some relief against the institutions of symmetry and stasis that so frequently informs the placement of windows and the skylights. In contrast to the indifferent 'yield' approach of centering windows in walls, the tools used in this research offer an organized approach that, with the support of simulation, leads to a higher-performing and more dynamic architectural space.

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ENDNOTES

1. At this early stage of research, the algorithms have some technical shortcomings that are important to consider. The first of these shortcomings is the limitation in programming resources: ideally, these algorithms would be entirely automated, requiring no user input as they operate. Additionally, the algorithms have yet to be automated between programs, and instead data is passed off manually. The result is a great deal of tedium and an effective limit on the number of iterations which results in a rather coarse optimization. A second technical shortcoming involves Ecotect, where analysis is limited by the number of data points and the accuracy assigned to the analysis; limitations to each of the latter make the effects of internal and external reflectance also somewhat coarse. This issue has been addressed by rendering solutions using physics-based rendering that can show the effect of reflectance on light distribution.
2. The narrow objective of daylight performance in the research must also be considered, in that the experiments focus solely on daylight factor data as the criteria guiding the algorithms, and direct solar admittance, construction imperatives, available products and materials, etc. are issues that have no effect on the optimizations as they would in a architectural project bound by real world factors.
3. Yet another important observation from this research is that the relationship between daylight intensity and uniformity is one that at times is disruptive: high or low daylight values in a room tend to increase or decrease statistical variance respectively, impacting standard deviation and uniformity. These tendencies complicate the interpretation of results, since low daylight factors may be undesirable for a certain task, even though low values result in high uniformity and reduced glare.
4. Lastly, in terms of representing real world performance, the simulations and optimizations in this paper offer a useful prediction of daylight performance – but they because they are based on daylight factor analysis and the uniform sky conditions used in that analysis, the models do not represent performance under direct sunlight or mixed sun and reflected cloud light conditions. Because of the varying conditions of daylight over the year and depending upon location, optimizations of the sort proposed in this paper would be irrelevant, since introducing the huge range of daylighting conditions into the optimization would make it unresolvable. Like any simulation based on daylight factor analysis, we must accept that for a reasonable range of conditions (especially cloudy and mostly cloudy conditions) the conditions of the analysis will represent a part of real life.

Temporal processes in research, green building and material reuse

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ABSTRACT:

Design to reuse materials has been difficult to systematize in the built environment. Incorporating reclaimed materials pushes the boundaries of the processes of standard materials selection, sourcing, and use. This paper will examine the melding together of a process of building deconstruction and an intensive group design process, to create a way for materials reuse to become more universal while not losing the trans-mutational qualities of reclaimed materials as they evolve from one building to the next. These tandem processes allow designers and builders to develop an attitude toward salvaged material that leads to an integrative method to guide the design, and conversely, the design to guide the reclamation process. The practice of design / build is a strategy to link sustainable design methodologies to the harvest of discarded materials and buildings. Design and building are often a process of reconciliation between process, material and vision. Quantifiable processes are a mode of operation that can be overtly included in the visioning for such projects.

In the deconstruction of a 150-year old barn addition and the building of a mobile shade structure at Yestermorrow Design / Build School in Warren, VT in the summer of 2010; the students and instructors engaged in a tandem process of deconstruction and design / build. The project led to a method in which assessable results and methods were considered in depth and were laid out within a larger structure for conveying the temporal possibilities for salvaging and designing with reused materials. It was the confluence of that practice and the group design / build procedure in a compressed amount of time that led to a materials transformation and use schema that hints at more universal possibilities in the future.

CONFERENCE THEME: Ecology, sustainability, and changing societal and political economies.

KEYWORDS: deconstruction, design / build, reuse, sustainable design, life-cycle

INTRODUCTION

There is a gap in sustainable building design research and practice with regard to one of the most effective means of reducing environmental impacts while engendering cultural and aesthetic possibilities. This gap exists between the first end-of-life (EOL) of buildings and the potential for their reformation; it is a potential to generate a systematic and yet creative practice embodied in the extended use of materials that might otherwise become waste. Built works can be seen as temporal products of an on-going process of building, as opposed to fixed artefacts. This stance incorporates the perspective of design in service to time-based processes of collaborative design, construction, use / users, change, and end-of-life to reconstruction. The transition of materials from deconstruction to reconstruction can become a phase where investigations take place to more fully realize ecological life-cycles of building.

Deconstruction can be defined as the selective dismantling of building structures to recover the maximum amount of primarily reusable and secondarily recyclable materials in a safe and cost-effective manner (Guy 2006). Tandem deconstruction / design / build and materials-use processes can provide exemplars for sustainable design methodologies. Stewart Brand writes of architecture being “trapped” by insisting that it is “the art of building”, when it could be redefined as the “design-science of the life of buildings.” (Brand 1995).

The reuse of materials has been hard to quantify and replicate in a universal manner in construction. Incorporating reclaimed materials into designs pushes the boundaries of the basic processes of materials selections, sourcing, and use. A rare example of taking on this challenge is the Materials Testing Laboratory by Busby + Associates Architects. This project utilized reclaimed materials from structural to finish systems and was eventually commissioned as a project management team with the responsibility for the reclaimed materials more or less placed entirely on the design team (Taggart 2007). Breaking with traditional roles for the architect was key to this project’s success.

This paper will examine the melding together of a quantified process of materials salvage and deconstruction, and an intensive group design process that created a way for the output of materials reuse to become more universal while not losing the trans-mutational qualities of reclaimed materials as they evolved from one building to the next. A parallel process allows designers and builders to develop an attitude toward salvaged materials that integrates the materials into design, while the design is also guiding the reclamation process. Design / build is a practice of reconciliation between process, material and vision. Measurable outcomes and formalized processes might be more overtly included in these types of projects to enable research and education for practitioners and students, respectively.

Even with the codification of architecture and construction in the modern era around concerns for life, health and safety, and more recently environmental criteria, materials conservation is not typically a priority in the design process (Osmani 2001). The research and teaching described herein is predicated on the idea that the processes of recovering materials from existing buildings, and designing to retain their useful functions and embedded energy is a relevant form of practice. This practice, although specialized, offers the construction industry an opportunity to be its own material stock in lieu of the ever expanding extraction of resources from the natural environment and return of waste. It also encourages local materials use and the values espoused by 'slow design' by making these principles real, and learning them by practicing them. According to Slow Lab:

“Slow Design’ is a holistic approach to creative thinking, process and outcomes. It envisions positive human and environmental impacts of designed products, environments and systems, while constructively critiquing the processes and technologies of which they are born. It celebrates local, close-mesh networks of people and industry, it preserves and draws upon our cultural diversity, and it relies on the open sharing of ideas and information to arrive at innovative solutions to contemporary challenges. Slowness doesn’t refer to how long it takes to make or do something” (Slow Lab 2010).

This deconstruction / reconstruction practice is not predicated on purely environmental metrics such as CO2 emissions avoided, or reduced volumes of materials deposited in landfills. It is also a practice of connection to the memories of the past, to materials qualities, and embedded materials culture of regional building and craft traditions (Adams 1998). Conducting building dismantling with the goal to reuse the materials in a design / build project and then actively integrating the deconstruction and reuse process with the design process illustrates design stewardship for architects and students that expands the notion of buildings from the present tense of ‘built’ to a time-based reality of ‘building’.

I. DECONSTRUCTION

I.1 OPERATIONAL PRECISION FOR UNIVERSAL HARVESTING

Relative to the processes of deconstruction, the methods detailed here arise directly from repeated experience in taking apart and salvaging buildings. Students in the “Design for Deconstruction and Reconstruction” course at the Yestermorrow Design / Build School, Summer, 2010, engaged in deconstruction, assessment and processing of salvaged lumber as a method for sourcing materials. At the same time, they integrated the materials into a design methodology that folded into an integrated group-design process.

The procedure for deconstructing a building is fraught with risk and discovery. Every old building has its specific challenges, and its peculiarities. Similar materials may have many variations based on construction and use impacts. The process of extracting materials from a building with a history, and construction that predates current methods requires a measured and exacting approach. The consideration of the progression of dismantling must first start with a contemplation of the end point. What are the material goals for this building in a second life? This process of reflection at the beginning of the design includes an assessment and categorization of the materials to be reused from an old building into a new project along the following three categories:

- Repeat – reuse same: materials that are easily reusable as-is and can be reused the same way while retaining the maximum amount of original integrity and appearance of use with little to no alteration.

- Renew – new and different use: see materials that can be used differently with creative processing, and may include a change in their qualities to be more like new, i.e. “cleaned-up”.
- Rethink – new + old: see materials that can be made like-and that can be combined with new materials to in effect make a different product that is then used in a different way than the original, however still as reuse.

Each categorization provides a waypoint to familiarize the possibilities of materials reuse. The categorization must be fairly systematic, can be ongoing and includes discoveries that happen as the process unfolds on-site. The possibility of change and discovery is controlled through this rigorous categorization. The chart below shows how materials were assessed in a previous project using these categories of materials possibilities. It gives both guidance and a set of possible benchmarks against which a harvest can be compared at the end of the process (Guy and Williams 2003).

Material	Potential Uses	Repeat	Rethink	Renew
Bead board	Interior wall and ceiling finish or wainscot	•		
	Cabinetry or door panels			•
Brick	Walkway, fireplace, planters, decorative column base, landscape screen wall	•		
1x4 T&G flooring	Flooring	•		
	Flooring mixed with new wood flooring of same profile			•
1x6 Novelty Siding	Used as an interior finish on the common wall between the main building and The Project		•	
	Used as part of a door panel		•	
1x8 Roof Sheathing	Sheaving		•	
	Casework		•	
2x4 Framing	Interior partition wall framing ⁽¹⁾	•		
2x6 Floor Joists	Exterior wall framing ⁽¹⁾		•	
4x6 Floor Beams	Wall framing ⁽¹⁾		•	
	Remilled rustic window sill or exposed door header			•
Solid wood cabinets	Casework	•		
Freestanding pass through cabinet	Casework	•		

Fig. 1: Identification of potential design palette in an existing building’s salvaged materials

Establishing safety and work processes on site sets the stage for the orderly consideration of such a possibly disorderly object. The formalization of a set of fundamental concepts is intended to begin the process of inculcation into the ‘unbuilding’ and ‘harvesting’ thought processes. There are many simple aphorisms used to convey mindfulness as students begin to see the rational process in simple steps:

- “Clean up as you go”
- “Treat the materials to be salvaged as though they were yours”
- “Be aware of others and your center of gravity”
- “Remove the connection not the material”
- “Know the structure”
- “Work from the point closest to the exit into the building”
- “Consider multiple routes to remove materials as directly to the ground as possible”
- “Use the building as a scaffold”
- “Always know which “pile” a material goes to before removing it from the building”
- “Carry “naily” boards the least distance and the un-nailed boards the most distance over their journey”
- “Use the appropriate tool for the task and minimize effort through the physics of leverage”
- “Move the trailer or truck to the materials not the other way around”
- “Analyze a removal process: by each sub-activity in sequence; tools; potential hazards and steps to mitigate them”

The goal of these expressions is to convey a state of attentiveness to context, detail and most importantly time and flow of an unbuilding process. It might be said that deconstruction knowledge is a form of heuristics, referring to “experience-based techniques for problem solving, learning, and

discovery” (Heuristics 2010). The deconstruction process is often times a discovery through problem-solving, in a partially known and partially unveiling context. In these terms it is perhaps a mirror image of the design / build process.

1.2 CHOREOGRAPHY AS MATERIALS TRANSFORMATION

Heidegger’s notion of the linguistic correlation between art and craft lies in the Greek’s use of the word *techne* for both disciplines. *Techne* is finally defined by Heidegger to mean a kind of practical performance. (Leach 1997). This idea of performing a task as a way of furthering one’s technical understanding is a mode of thinking about the deconstruction process. It is a kind of dance to take a building down to its foundation, as the group did in Vermont. The choreography of that dance serves to create a rhythm and space for consideration of materials that lead the group to innovate with the lumber taken from the site. This innovation is in direct relationship to the tandem process and *techne* that has arisen from the repetitive choreography of deconstruction. Here, the categorization of materials and staging is critical.

The rigorous management through consideration of a sequence and rhythm of matter extraction allowed for material innovation. An initial assessment of existing structure is just the beginning. Structure, non-structure, openings, pathways, vertical and horizontal relationships of the building describe the deconstruction choreography. This choreography results in a careful consideration of how the materials are sequenced in their removal. Throughout the entire process, the building must remain stable, and allow for itself to act as a self-scaffold for working. At the same time, avoiding the creation of any barriers that impede efficient removal of material is a priority. The structure must on occasion be systematically and artificially stabilized as an extra-precaution; but the goal is to avoid this as much as possible.

Part of this consideration of order and efficiency is to assess which parts of the building are core structure and original construction, which is secondary structure, and which parts are added at later time periods. In the case of the 1850’s Vermont barn, it was clear that the entire structure to be removed was built later than the core to remain. But within that younger portion, there were materials and parts that were added even later, had not fared well and were non-structural. Non-structural, non-core walls closest to circulation are removed first so that their component parts can be assessed and broken down, and gotten out of the way. These were quickly removed and assessed for reuse. As one set of materials or building assemblies was removed this created a new set of physical dimensions, pathways, openings, and so on, from which to base the optimal flow of the next set of materials. “LOFO: Last on First Off” is a way of thinking about this staging. At the same time an attempt is made to focus on materials types and as much as possible create similar groups of recovered materials at each step. As we mention here, this planning must be considered in detail prior to the commencement of deconstruction.

The scene of the site also becomes part of the dance of *techne*. The removal of materials from the building is the first complicated step of this dance of reuse. The image below shows a triangular organization developed by one of the instructors through much repeated experience with deconstruction. This triangle staging area allows for each piece to be removed directly, undergo a superficial processing as it is removed and re-assessed, and subsequently stored for processing. Removal may occur based on timing or organization of the transport, reuse by others, etc.

The repetition of this judgment by various parts of the team, while also considering design possibilities within the project led each member to have thoughts about material application that came from an immersion in the harvested material. This repeated divining of suitability gave each team member the opportunity to develop tectonic sensibilities about the design / build project that were both overt and subtle; again, here material choreography leads to material knowledge. It is through this repetitive choreography and assessment of materials - repeat, renew, rethink - that the team was able to unlock a more universal and agreed upon attitude towards the salvaged lumber.

1.3 DESIGN / BUILD

This project proposes an architecture design sensibility that is akin to a performative art. This tradition is realized in the modern version of the design / build concept (Mannell 2006). A focus of design / build education and tradition is the Yestermorrow Design / Build School. The Yestermorrow Design / Build School was founded in Warren, VT in 1980 by John Connell (Palladino-Piedmont 1997; Sagan 2008) Principles of design / build practice include: control of the economic production of buildings by the designers themselves, speculative development as practice as opposed to traditional architectural practice models, a desire for hands-on direct physical involvement by engaging in the materiality and empirical qualities of architecture, and creative and artist expression in the medium of architecture and building (Sagan 2008). A non-technical definition of design / build is as follows: “about the art of making buildings, rather than making information for others to make buildings” (Piedmont-Palladino 1997). This lends itself to the idea of building making as a performative act. It is, in effect, a process of designing through building and within context as literally as possible. While some amount of planning is essential a key distinction is that the work is begun before a complete conceptualization is accomplished, and therefore the time and experiences of the building process become integral to the shaping of the final product.



Photo 1: “Work triangle” for materials coming building under deconstruction

The ultimate result of this design/ build method as practiced via Yestermorrow School is of dynamic buildings that evolve from an active process rather than any predetermined idea (Sagan 2008). Schon espouses a theory of knowledge based upon reflection “in action” and reflection “on action” that is often described as reflective practice. This reflective practice allows for both givens and opportunities for change within a design process (Swann 2002). Design, as distinguished from art, is a social process for the designer in relation to a team, a client, and the project context. As such this approach to building lends itself to a complementary relationship with the rigorous and detailed dissection of existing buildings for the sometimes uncertain harvest of materials. The open-ended nature of realizing built form in direct physical conception, is a way that material discovery can lend itself to material innovation. This innovation is then allowed to be tested on the harvest, and drive the design as the concurrent process of design and material gathering move forward together.

2. PROJECT DESCRIPTION

In the deconstruction of a 150-year old barn addition and the building of a mobile shade structure at Yestermorrow Design / Build School in Warren, VT in the summer of 2010; the students and instructors engaged in a tandem process of deconstruction and design / build. The project was designed so that results and methods were considered in depth and are laid out within temporal possibilities for salvaging and designing with reused materials. It was the confluence of a measured deconstruction practice and a group design / build procedure in a compressed amount of time that led to a materials transformation and use schema that hints at more universal possibilities in the future.



Photo 2: View of barn from the Southeast with secondary structure to be removed on the right



Photo 3: View of barn from the Northeast with secondary structure to be removed on the left



Photo 4: Back wall being removed by group effort



Photo 5: Main element after removal of secondary element



Photo 6: Salvaged lumber at Yestermorrow



Photo 7: Materials dressed from the site and experimentation in the shop

2.1 DECONSTRUCTION

The students and instructors in one week systematically took apart and salvaged a large portion of a 2-story 2,400 square foot heavy timber building. The building was originally built in three stages: the core barn which was a simple gable-roof structure; then a shed-roofed extension spanning the long side of the south side; and another smaller addition off of the first addition. This final addition was severely damaged and was removed before the project started. The deconstruction in this project consisted of removing the first addition, a 2-story element approximately 16' x 24' seen in Photo 2 & 3 extending from the main structure. Although the roof was tied into the roof of the main element

at a mid-point on the primary structure rafters, it had a separate post and beam frame which allowed it to be removed independently of the main element in a line with the main timber frame. The main timber frame throughout was in-filled on the exterior walls with vertical 2x4 framing onto which the exterior siding was attached. The roof was metal v-crimp roofing attached to 1 x sheathing. The preliminary steps in the process were to categorize the main materials and their relation to the potential design and functional qualities of the proposed shade structure.

Without resolving either the actual yield of the deconstruction or the final design of the new structure, a dialogue was established in the conceptual and schematic design stages, which continued as the deconstruction began. The initial planning of the deconstruction revolved around safety, logistics of the movement of people, tools and materials, and the basic sequencing of the process in terms of the last-on, first-off construct (with variations created by the requirement to leave the main building element in a stable and protected condition). With multiple possible uses for the materials in mind, the materials harvest is segregated into categories of disposal, recycling, and reuse: with the reuse further segregated for potential reuse in the follow-on reconstruction of the main barn on-site; reuse by the project team; reuse by others such the Yestermorrow School in the future.

For each category their disposition is planned: placed inside of the main structure for reuse by the follow-on project; a 'metals pile' for recycling; waste bagged or piled where it can be easily picked-up; and project or Yestermorrow reuse processed such as de-nailing, rough trimming, stacking in categories for loading on a pick-up truck or trailer. This further categorization of the materials, beyond the broad reuse or recycle categories described above, is by type, dimensions or qualities within a single type. The possibilities for the treatments of repeat, renew, and rethink described earlier were then able to be considered.

2.2 GROUP DESIGN / BUILD PROCESS

Based on a group process first developed by Jersey Devils founders and design build pioneers Steve Badanes, John Ringel, and Jim Adamson; the material harvest group engaged in an intensive on site design process that centred on preparing to re-use the harvested materials. This method worked to bring students together around an idea, and to allow students to explore new ways of making that they have not had an opportunity to be involved in. (Badanes, 2009) The universal professional studio practice is as follows: schematic design, design-development, and construction documentation and construction administration. (Demkin, 2008) Design / build practice is a truncated version of this in which the construction documentation and construction administration phases occur simultaneously with the construction phase of the project and design often bleeds into construction. (Beard et. al, 2001) In the design / build studio students are engaged in a process of learning by making something physical. This route can create a stronger link with materials exploration in the design process and in the final result. This reality differs from the usual studio process in that the implementation of the project causes students to fully question their assumptions about the design and the materials. (Wilkinson, 2007) It is this questioning that held value for this project. The fact that phases of a project which usually function discretely are now blended together leads to tremendous opportunity on this front. In the studio practice taught here, the group was asked to consider materials as a driving consideration for the design. Discussions about the possible use of what was being harvested were constant and on-going. The group was intentionally trying to discover ways of making through the process of unmaking. In setting forth on the design portion of the class, the process was laid out as follows.

2.3 BUILDING CONSENSUS

The group process to build consensus behind one larger idea occurred in tandem with materials discussions and explorations as the harvesting moved forward. The group deconstructed during the day, and designed at night for 3 days. The daytime discussions on site centred on how what was being taken from the site could be efficiently used and processed, both in the project at hand but also in the larger community. The group started by coming up with individual ideas that were meant to satisfy the program of a sunshade for an existing plaza. Ideas of mobility and modularity were discussed at length and many options for program expansion and contraction were considered.

Students each came up with two or three ideas and the group categorized these ideas by their similar natures. These design categorizations lead to the forming of 4 smaller groups which then distilled and developed these into slightly more coherent group ideas. The groups got larger through several rounds of design over several days that were filled with deconstruction work on site following the rigorous deconstruction methods laid out previously.

After considering many options and the similarities between them, the group finally found consensus in the possibilities of making the sunshade mobile for use on any part of the existing campus. This led to the discovery that the shade part needed to be extremely light. During the day, participants were taking heavy hundred-year-old boards out of the building on site. The contrast between the heaviness of these boards and their possible use was considered as work progressed both on-site and in the design studio space. As the groups' ideas coalesced, a large volume of design sketches were generated that became more and more specific. These sketches lead to a series of smaller working drawings which were produced as the building of the agreed upon design commenced. As building grew the participants were encouraged to consider their design idea while harvesting the materials on site and material attitudes began to come into focus.



Photo 8: Group design and sketching

2.4 MATERIAL PROCESS: LEARNING BY MAKING

Material thought and research was then conducted in smaller groups which became the driving forces in different parts of the project and worked to solve issues within each of these parts. This progression started with materials investigation which included processing the material on the site, categorizing material based on the three ideas of repeat, renew and rethink; bringing back portions to experiment with and sketching possible uses for different types of material. In this way the schematic phase of design became an active participatory phase with materials as part of this phase. The continued daily engagement on site also contributed to the shift in how this phase functioned. The fact that here, the group design process also overlapped with what would be the design development phases in a more conventional design progression; and both were occurring by the same set of hands, led to a feedback loop of materials reuse and dressage.

2.5 LOOPING ON-SITE MATERIAL HARVEST AND HARVEST CENTRED DESIGN

At a certain point in the one-week process the group became a machine for looping the ideas from the site into their project. After the initial design sketches were completed and consensus reached; the group started to focus on how they were assessing and dressing the materials on site and at the fabrication space. Broken into groups that included wing, structure, wheels and connection; each team produced detailed material experiments. This team approach to both taking apart and building was the key to making discoveries and creating a group lexicon for using the materials. This led to an almost frantic processing of site material as construction went on.

One example of this is the direct and rigorous process by which many 150 year old boards were processed on site, and in the wood shop. They then became integral to the project. The project design that emerged from the group process required lightness by its very nature. Because the group had settled on a mobile project, the fact that many of the salvaged boards were quite dense and heavy with beautiful graining became one point of experimentation in the group. The teams undertook a process of denailing and planing that revealed true value in the salvaged material and was extremely repetitive in nature. This process revealed that by long cutting or ripping the boards into flexible strips, one could create lighter yet stronger truss structures that allowed for the light-frame construction required by the mobile sunshade program. By making strategic planning and cutting decisions the group was able to leave some of the original rough-hewn salvaged surface intact and create beautiful newly sawn surfaces that were appropriate for precise building. In this way a feedback loop was developed between material experimentation, the rigors of site material selection, dressing of lumber, and the design / build process. It is our belief that this loop which took place on several levels in this process, including working with salvaged hardware and heavy timbers for the structure of the project, hints at a more universal possibility in salvaging buildings. If design and salvage can be undertaken rigorously and at the same time, the peculiarities of the building carcass and specificity of the desired finished object begin to meld to each other in a way that allows greater efficacies for both processes. In other words deconstruction and reconstruction become one process.

Based upon a survey-based estimate by one of the authors, reused building materials sold annually in the US (excluding antiques, specialty products, etc.) is approximately 0.2% of total debris generated from building activities (construction, renovation, demolition) in the US each year. The overall reusable fraction of building materials debris is anywhere from 5% -25% of total debris generation dependent on project type and materials of construction. A new construction project may have materials in excellent condition, however generally this waste is in lesser states for reuse. A renovation or demolition project has potentially the entire stock of the building however the effects of construction and use may lower its reusability. Nonetheless, there is potentially a 25-125 times increase in the amount of 'wasted' materials yet to be reused annually before reaching the full potential for reuse of building materials per year in the US.

In this project, the deconstruction resulted in approximately 30% of the existing materials recovered for reuse by the project, by Yestermorrow, or by the community (clean wood and metal roofing); 30% recovered for recycling (clean wood); and the remainder as disposal (primarily painted wood). The class used as much as was needed to complete the design / build project and the rest was left for future reuse by the Yestermorrow campus. This project exceeded the statistical norms for material salvage and the authors believe this to be due to the difference in practice here. The pairing of design and build processes with deconstruction meant that the users of the materials were actively participating in their salvage and processing. This we believe has led to higher efficiency in volume of salvage, and also community interest in the salvaged materials for other uses.



Photo 9: Assembly-by-design process



Photo 10: Assembling the components



Photo 11: Final result

CONCLUSION

Richard Sennet in his book “The Craftsman” explores a concept he refers to as “being as a thing” he maintains that at a certain point in the process of making after a definite amount of time; one reaches mastery of a process and a maker no longer feels a separation between their hand and the act of making (Sennet 2008). This idea of mastery is attainable within the realm of deconstruction and it democratizes the reuse of materials. It is achieved at the point when the materials are transformed through a rigorous on-site and in-shop process that feeds upon itself. In the project described here the process was both specific and universal. Through organizing the site, the choreography of the team and the repetitive nature of the tasks; the project began to emerge from both the process of deconstruction and reconstruction.

In this confluence of destruction and rebuilding, a fluidity of procedure emerged. Because the specificity of materials to be reclaimed, often limits applicability in the realm of construction; materials reuse has not been adopted as a widespread practice in the building industry. Evident in the interlocking practice of deconstruction and design / build this possible universality may not be limited to student projects. At the same time both processes follow a defined logic that creates a methodology that is specific and flexible, in other words when practiced concurrently, these procedures allow the materials to be used more fully. Clearly, a robust and rigorous on-site choreography and assessment of materials, coupled with an equally rigorous design build process, leads to an extremely efficient use of reclaimed materials. The project described here left behind a store of useable material both on site and at the fabrication site that was utilized by other groups and the surrounding community. By partnering the deconstruction with immediate group centred re-construction-universal dissemination of reclaimed materials became possible around the project. The hope is that through a continued approach to projects such as these, the ability to reclaim buildings and materials within the existing built landscape will not be held back by the specificity of the beginning and end points in the process.

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Toward an Analytic Framework for Active Living Strategies in Parks and Recreation Systems

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ABSTRACT:

The predicament many communities face with obesity and other diseases related to sedentary lifestyles has brought to light the symbiotic relationship between the built environment and active living. In this context, architectural and planning research has a crucial role to play and the significance of a conceptual framework that incorporates insights from multiple design disciplines and scales is of paramount importance. This paper focuses on the analytic framework of research that affords potential improvements in the parks and recreation system with the objective of promoting active living in Pennsylvania's Pottstown Area. The approach centers on planning and design strategies for improving the health and wellbeing of residents. It highlights critical issues the area is confronting in terms of growth, sprawl, land loss, access to opportunities at parks and recreation facilities, and programs that affect active living. The analytic framework is informed by The Ecological Model of Four Domains of Active Living developed by Sallis et al. (2006). According to this model active living occurs in four domains of life that include: active recreation, active transportation, household activities, and occupational activities. Our research underscored two of the four domains of active living identified in the model: active recreation and active transportation. The framework recognizes that though it is useful to conceptualize the two domains separately, in actual practice they are closely intertwined. The structure of the study holistically incorporated both domains of active living in the context of distinct levels of influence, which included the neighborhood and policy environments. The analytic framework facilitated a substantive assessment of crucial aspects of existing parks and recreation facilities. This research has contributed substantially to providing a framework for socially relevant, environmentally feasible, and politically viable strategies. The framework it proposes would guide municipalities and planning or design agencies involved in the research process.

CONFERENCE THEME: On Approaches

KEYWORDS: analytic framework, active living, parks and recreation, strategies and guidelines for active living

INTRODUCTION

This paper discusses the analytic framework for a research project that focused on how design and planning strategies for park and recreation systems can encourage active living. Through an assessment of various factors critical to active living, such as the quality of the built environment and the residents' perceptions, needs, and aspirations, the study emphasized the development of an analytic framework that culminated in broad guidelines.

Funded by the Pottstown Area Health and Wellness Foundation (PAHWF), this research identified critical components of the built environment to promote healthy lifestyles. Specifically, the research focused on how design and planning strategies for parks and recreation can encourage active living in Pennsylvania's Pottstown Area. Strategically located at the intersection of the Manatawny Creek and the Schuylkill River, the Pottstown Area's proximity to Philadelphia, King of Prussia, and the Schuylkill River accords it great importance in the region. PAHWF supports about 150,000 people in this region—spanning Berks, Montgomery, and Chester Counties in a ten-mile area around the Pottstown Memorial Medical Center. The geographical and neighborhood context map (Figure 1) highlights the study area within the PAHWF's ten-mile region. The core of building density is found in three major urban centers: Pottstown, Boyertown, and Spring City. These areas are home to commercial centers that support the surrounding suburban residential areas through employment and the supply of goods and services. Many of the outer parts of the study area have been traditionally rural and consist of agricultural land.

However, as prime farmland is rapidly consumed, giving way to exurban and suburban development, these classifications result in sprawling communities moving outward from the urban cores. These new suburbs lack vital qualities seen in traditional, pre-war suburban development, including dense land use, walkable neighborhoods, and multi-use zoning. The diversity provided by traditional suburban and urban areas supports active living lifestyles and encourages interaction between residents. Urban and suburban places share important characteristics, including the density of settlement patterns. Exurban and rural areas have different connotations today, many of which are inextricably related to land consumption and sprawl-related issues, and the Pottstown Area is not an exception in this regard.

The analytic framework developed for the Pottstown study recognizes these disparate conditions and allows the research to include relevant domains of active living in the context of distinct behavior settings, planning strategies, and policy environments. The ultimate intent of this two-year study was to provide relevant information and assessment related to the development of community conservation plans, programs, and projects on parks and recreation to encourage active living in the Pottstown Area.

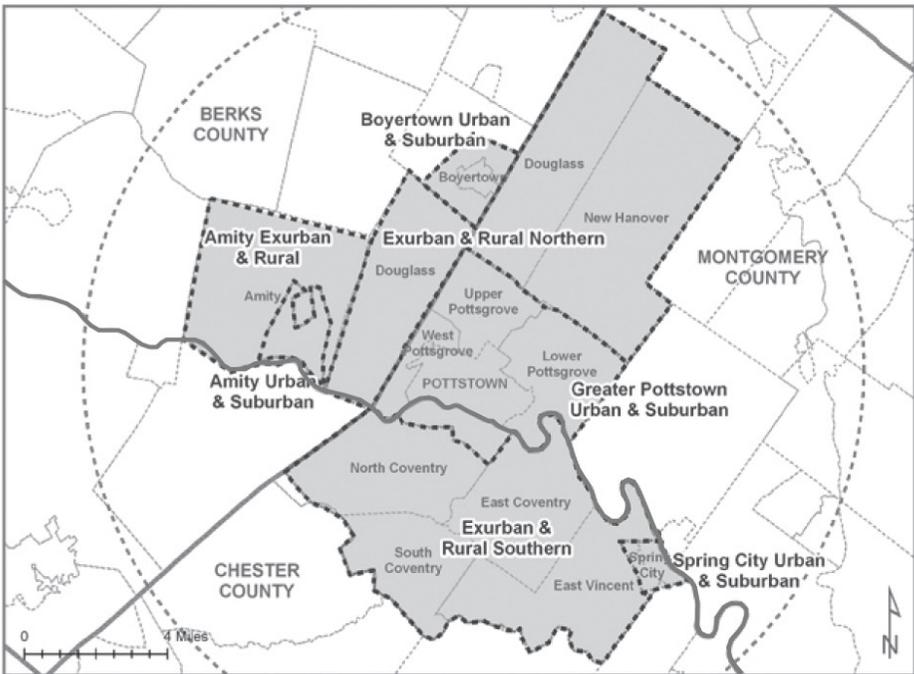


Figure 1: Study Area Geographical and Neighborhood Contexts

I. DEVELOPING ACTIVE LIVING FRAMEWORK

Several studies conducted within the last decade can provide a basis for an in-depth understanding of the Pottstown Area in terms of health, wellness, and active living. A brief discussion of some of these studies and their findings is critical in providing a developmental perspective for successful parks and recreation planning or design strategies.

Two studies conducted by Barton Smith titled “A Health Assessment of the Pottstown Area: A Report to the Pottstown Area Health and Wellness Foundation” (2004) and “An Independent Assessment of the Health, Human Services, Cultural and Educational Needs of Montgomery County” (2006) have useful implications for active living and parks and recreation for the Pottstown Area. The reports acknowledged that improving the health of a community is a difficult and multi-faceted task that

can only be accomplished through the involvement of all stakeholders. A physical environment that fosters collaboration and protects the health of residents by encouraging healthy lifestyles and active living is an essential first step in achieving this goal. A comprehensive and thoughtfully researched report, “Back to Prosperity: A Competitive Agenda for Renewing Pennsylvania,” published in 2003 by The Brookings Institution Center on Urban and Metropolitan Policy offers sobering insights into the current status of Pennsylvania, including southeast Pennsylvania. While recognizing Pennsylvania’s fundamental assets—its history, institutions, and industry, as well as the natural and built environment—the report presents disturbing patterns that need to change before Pennsylvania pulls out of this static growth pattern. Susan Landes (2006) conducted the “Parks and Recreation Peer Study” for the Pottstown Metropolitan Region. The intent of this study was to establish goals to coordinate parks and recreation opportunities among the region’s eight municipalities, which included Pottstown. The “Pottstown Metropolitan Regional Comprehensive Plan,” which was prepared by the Montgomery County Planning Commission in 2005, showed that, despite large amounts of open space, the need to provide residents with recreational opportunities still exists. The need for integrated planning, as well as the identification of areas in need of improvement, is emphasized in the report.

A number of studies that deal with the geographical and ecological significance of the Schuylkill River offer useful suggestions. “The Schuylkill Watershed Conservation Plan,” funded by the Pennsylvania Department of Conservation and Natural Resources (DCNR) and The William Penn Foundation, provides a guidebook for municipalities and conservation groups. Prepared in 2001 by The Conservation Fund, Natural Lands Trust, and The Patrick Center for Environmental Research at The Academy of Natural Sciences, the intent of the study was to articulate a long-term vision for the Schuylkill River Watershed. The regional nature of the assessment makes the study attractive for municipalities and non-profit institutions. The primary goals of the study were to: identify critical conservation issues, conduct an inventory and assessment of land and water resources, and make recommendations.

The foregoing discussion on related plans and studies conducted in the study area represents a useful body of work in terms of identifying a variety of critical issues. Collectively these studies enhance our understanding of the region and have been used as a springboard for this research. While there have been many attempts to address the critical concerns of the Pottstown region, a comprehensive and shared understanding or strategy is still absent. Similarly, an emphasis on the relationship between built environment and active living is singularly lacking in current studies. Understanding the value of comprehensive design and planning strategies in rectifying this situation takes on added importance. In fact, environmental and policy interventions have been identified as the most promising avenues for creating widespread improvements in physical activity, eating habits, and weight status (Lee and Moudon, 2004).

1.1. ACTIVE LIVING

Active living can be concisely defined as a way of life that integrates physical activity into daily routines (ALR 2010). It is a concept broader than just physical activity in the sense that it accounts for physical activity in all spheres of human life—work, play, transportation, and household activities as opposed to focusing on only leisure or recreational physical activity. Regular physical activity is important because it improves the quality of life and reduces the risk of chronic diseases like coronary heart disease, stroke, high blood pressure, Type 2 Diabetes, and some cancers (HHS Press Office 2008). When viewed through the lens of active living, health benefits associated with physical activity can be accrued in a variety of ways, such as walking or bicycling for transportation, exercise or pleasure, playing outdoors, working or gardening in the yard, climbing stairs, and using recreational facilities.

I.2. ECOLOGICAL MODEL OF ACTIVE LIVING

The Ecological Model of Four Domains of Active Living (Sallis, et al. 2006) is used to direct this study. In this four-domain model of active living, the outcome of interest is behavior, which occurs at the intersection of people and place. Drawing from a socio-ecological perspective, place is conceptualized in terms of behavior settings (Barker 1968, Rapoport 1990, Reed 1996), bounded places where particular activities occur. These settings provide cues or signals for appropriate rules and behavior. Both objective and perceived features of the built environment are involved in transmitting cues or signals about appropriate behavior. Characteristics like the size (length, breadth, etc.) of a setting and presence of physical elements in the setting refers to objective features, while perceived safety or comfort of a particular setting refers to subjective features of the built environment. The subjective features are more often linked to the larger sociocultural context within which settings are embedded and vary between people or groups. Thus, in examining behavior within the context of settings, the larger sociocultural milieu of the people and groups involved plays a significant role.

According to Sallis's model active living occurs in four important domains of life:

1. *Active recreation* can take place in neighborhood parks in a variety of settings that include athletic fields, building structures for recreational activities, community gardens, sports fields, children's play areas and so on.
2. *Active transportation* refers to any method of travel that utilizes human energy but most commonly refers to walking and biking.
3. *Household activities* are located in the home environment and include a wide range of activities. Some household tasks involve physical activity like household chores and gardening. The use of laborsaving devices and use of electronics (computers, gaming systems, and television) decrease physical activity and promote sedentary behavior.
4. *Occupational activities* usually refer to work environment for adults and school environments for children, youth, and young adults.

Within each of these domains of life, multiple levels of influence exist, ranging from intrapersonal or interpersonal variables to policy variables. The intrapersonal variables relate to individual preferences, as well as biological and psychological factors that influence an individual's perception of the built environment through active living. Interpersonal variables refer to the social and cultural environment, while policy refers to macro-scale societal variables, such as incentives for an auto-oriented lifestyle in the United States.

In addition, the natural environment and information environment affect active living. The natural environment consists of elements (like weather and topography) that influence air quality and ease of active living (like walking or biking). Information is present in every setting, and promotion of sedentary activities is especially ubiquitous in the United States. The information environment refers to elements of mass media and communications including news, advertising, billboards, and radio and television programs. Some elements of the information environment cut across domains/settings (like mass media sports programs that encourage passive viewing) while others are site-specific (like advertising of particular programs in a health club or television at home).

The model developed by Sallis, et al. (2006) is effective in capturing the complexity of the relationship between the built environment and active living in a general or universal context. It is, however, too broad in its scope and application for critical insights into design and planning interventions. In order to encapsulate the specific conditions particular to our study in a focused manner, certain aspects of the model were revised and adapted. The resulting analytic framework was designed specifically for our study, but retained holistic characteristics of the Sallis model.

The myriad but neatly defined social contexts in the ecological model do not fully embrace decision-making approaches on issues that impinge on the built environment at large. For example it is not clear how social determinants for management structures and partnerships help or impede active living strategies at the micro or intrapersonal level (Stewart 2009).

Understanding how design or planning decision-making mediates between the micro, meso, and

macro levels (Bronfenbrenner 1979) is essential to developing socially viable, politically feasible, and environmentally responsible approaches (see Figure 3). Without substantive operational dimensions, a conceptual model cannot adequately address the multifaceted aspects of active living strategies.

While the sensibility of the Sallis model provides a comprehensive vision of the complexities and intricacies of the relationship between active living and community dynamics, the model falls a little short of providing tangible strategies for making active living an integral part of parks and recreation systems and does not fully address the question of what needs to change in the existing context (Stewart, 2009).

2. ANALYTIC FRAMEWORK OF STUDY

The Sallis model, which is based on a priori and cross-disciplinary knowledge, is a useful springboard for the development of our analytic framework because it encapsulates the complexity of the relationship between the built environment and active living in a wide-ranging context. While there are similarities, there are also certain noteworthy differences. The characteristics that are substantially different in our analytic framework can be summarized as follows:

- Focus on the built environment at three scales necessary to affect change in order to encourage active living: macro or policy environment at the regional level and beyond; meso or community-level issues and park systems; and micro or individual neighborhood characteristics, as well as design and management of parks.
- Emphasis on social and physical factors that directly relate to design and planning dimensions of parks and recreation systems.
- Knowledge and insights generated through an understanding of universal concepts and their relevance to a particular situation; or in other words a holistic view of a particular place—i.e. the Pottstown Area.

2.1. ACTIVE RECREATION AND ACTIVE TRANSPORTATION

This study specifically focuses on two of the four domains of active living identified in Sallis's model: active recreation and active transportation. The reason for this selective emphasis is that parks and recreation opportunities most closely align with these two domains. Active recreation is focused on the physical activity within parks, and may be associated with availability and appropriateness of facilities.

Active transportation underscores an easily overlooked aspect of active living: getting to and from parks. Park features have been found to be more important than proximity to home (PCPFS 2008), suggesting that people visit particular parks within a network for specific facilities, rather than visiting parks closer to home. Once park distance exceeds a walking distance (half a mile is the general standard or estimate), it is perfectly reasonable to assume that other forms of transportation, especially automobiles, will be used. In this case, the opportunities for active transportation as an integral part of active living are lost.

Though it is useful to conceptualize the two domains (active recreation and active transportation) separately, in reality many of their elements are closely interrelated and interconnected. For instance, while street network patterns are part of the active transportation domain, they also have bearing upon recreational opportunities by providing easy (or potentially problematic) access to parks and trails (part of the active recreation domain).

2.2 DEFINING THE ANALYTIC FRAMEWORK

In our analytic framework (Figure 2) two of the four domains of active living in the Sallis model—active recreation and active transportation—are especially highlighted. Thus, in structuring this research, we holistically consider both domains of active living in the context of distinct behavior settings and policy environments. The behavior settings under investigation in this study are the

neighborhood environment and recreation environment. Within each of these settings we specifically focus on the existence of and access to pedestrian/bike facilities and parks/trails as well as their particular characteristics. Within the policy environment, this study concentrates on zoning codes, land use policies, and management structures and partnerships as they relate to active recreation and transportation.

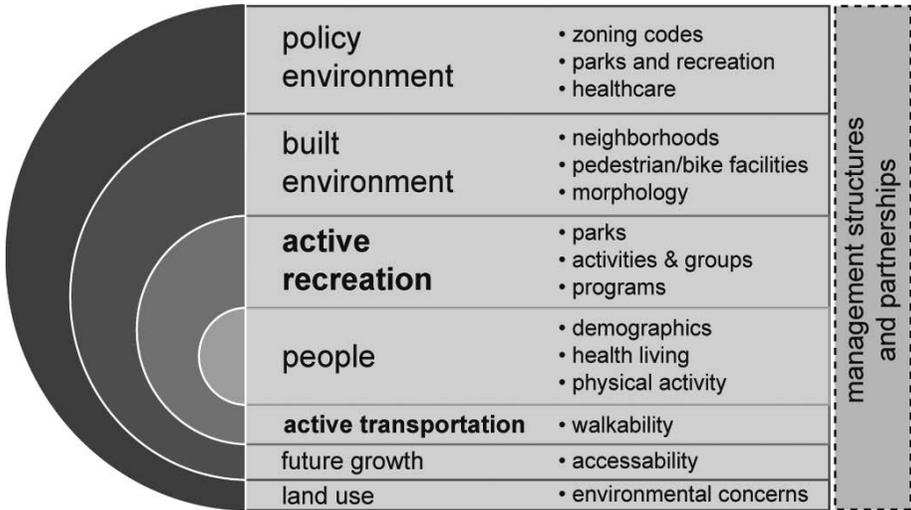


Figure 2: Analytic Framework of Study

Management structures that promote partnerships are crucial at all stages in the analytic framework—from people to policy levels. Our framework acknowledges that the large number of municipalities affects active living in the study area. To encourage viable active living strategies, thoughtful multi-jurisdictional planning and land use initiatives that result in working collaborations with surrounding townships and boroughs are vital. The parks and recreation field must recognize the need for developing viable partnerships with related fields and to become more integrated in active living strategies.

When examining behavior settings, we concentrate on groups that are likely to be insufficiently active or inactive. This is motivated by the need to understand the reasons for inactivity, and in doing so, develop strategies to increase activity levels of groups that would benefit most from increases in levels of physical activity. In other words, we emphasize high-leverage groups (Stokols, 2000) that are likely to benefit the most from successful physical activity interventions. Thus, the focus of this study is on behavior that takes place at the intersection of specific groups and environments (Figure 2)

2.3. COMPONENTS OF THE FRAMEWORK

The socio-ecological perspective of active living is employed to direct this study because it allows for the incorporation of a wide range of factors at multiple scales with an emphasis on micro-, meso- and macro-level scales. Micro level is the smallest of the levels of the environment, akin to the individual at the neighborhood scale, the meso level is the middle ground, and deals with the communities in the region, while the macro level represents the largest level, dealing with institutions and policies.

Because ecological analysis takes a place-based perspective, it is particularly suited to the study of issues related to active living, as physical activity tends to be a place-based activity. Specifically, these scales allow valuable and holistic insights into design and planning strategies for the parks and recreation system.

- At the macro-scale, we examine land use policies and zoning codes as they relate to active transportation and active recreation. We conclude by examining partnerships/organizing structures with respect to Planning Commissions and Parks and Recreation agencies as they work to meet the needs of the Greater Pottstown Area. Figure 3 illustrates how these various elements are interrelated and interconnected.
- At the meso-scale, we focus on pedestrian/bike facilities and streetscape elements that promote active transportation and provide links to parks and recreational facilities.
- At the micro scale, we then investigate parks at the neighborhood scale in terms of the facilities offered and user groups (children, adolescents, young adults, adults, and seniors).

The analytic framework of this study allows the concept of active living to be considered with regard to multiple scales of influence. It entails complex feedback loops involving behavior as signified by the two domains of active living: active recreation and active transportation. Such a framework represents the interface between people and environment and creates a reciprocal relationship among all the critical elements (Figure 3).

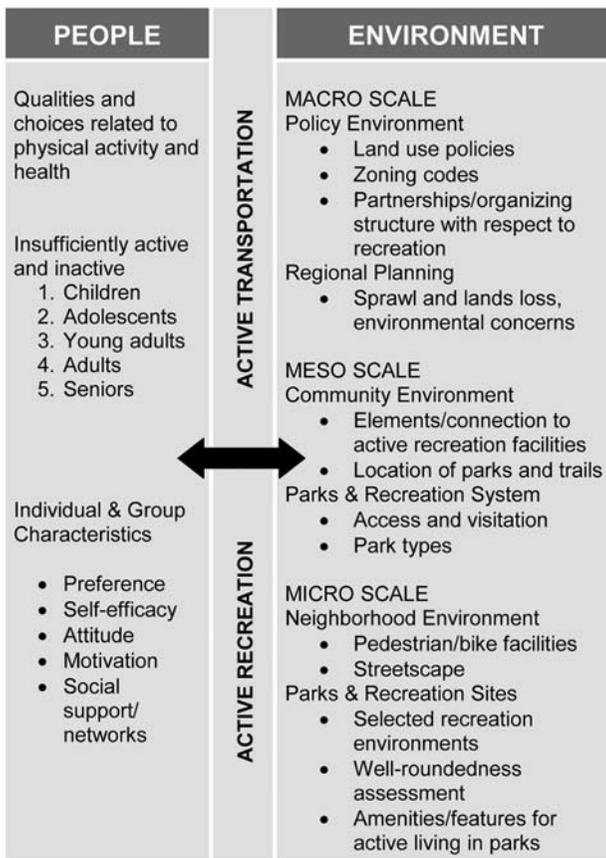


Figure 3: Diagram of Study Elements

2.4.ANALYSIS OF PARKS AND RECREATION SYSTEM

Our analytic framework is based on a structure that enables a complex understanding of how parks and recreation spaces represent a significant resource for active living. As municipally owned amenities, they are free and accessible to the public. As a network or system, parks and recreation sites potentially offer a range of facilities that accommodate all age groups.

A majority of studies correlate proximity to parks with increased physical activity (PCPFS, 2008). The literature on physical activity and parks points to three characteristics that affect park usage for recreational physical activity: accessibility, availability, and quality of amenities (Cohen, et al. 2007). Other researchers have noted that in addition to location and park features, three additional factors are important for users: programming, outreach, and safety and maintenance (PCPFS 2008).

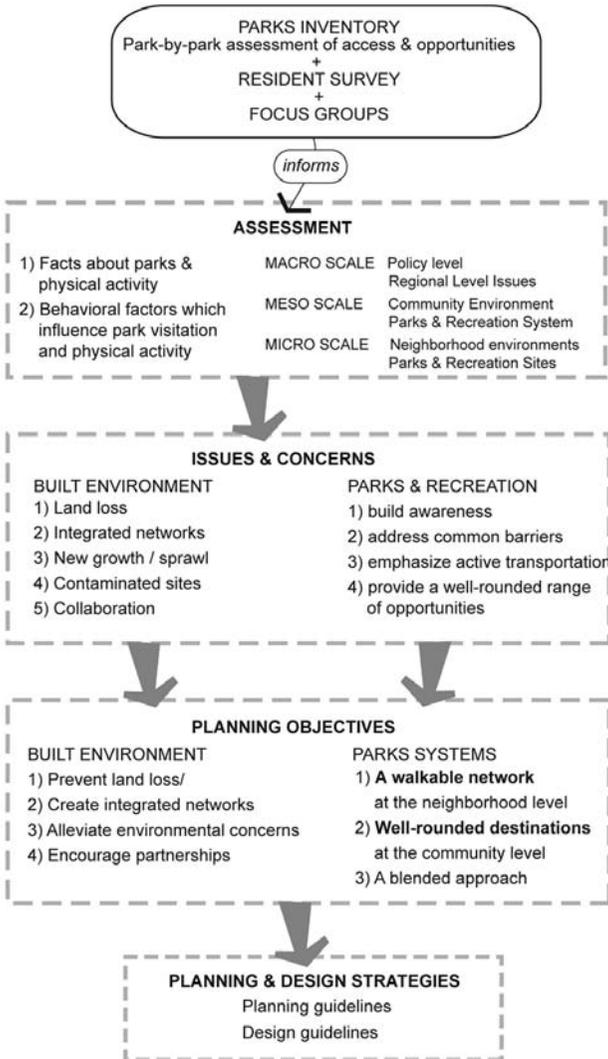


Figure 4: Diagram illustrating the process of identifying gaps in knowledge and creating guidelines

Any single park within the overall park system is located in proximity to a certain proportion of the overall population. It is also located within a unique configuration of street networks, which affects access by walking, bicycling, private and public transportation. The relationship of street networks and the population helps to determine the overall accessibility to the individual parks. When taken as an overall park system, the aggregated access reveals the percent of the population with access to the combined facilities of the park system by transportation mode.

While at least one half of the activity occurring in parks is physical, people visit parks for a variety of health-related reasons. Approximately 80-percent of Americans use local parks and recreation facilities (Henderson 2005) and not just for physical activity. Many common non-sports activities are important and merit further study. Connections to the natural environment, contact with others, and experiences with historical and cultural narratives contribute to a well-rounded park network. This suggests that creating well-rounded parks and recreation spaces may encourage more local visitation, thereby potentially increasing the prevalence of active transportation. To these ends, the Pottstown study evaluated the parks network based on three crucial factors: accessibility, availability, and quality.

Successful interventions in the built environment “should (a) ensure safe, attractive, and convenient places for physical activity (Sallis, et al. 2006).” Many factors influence active living and the urban, suburban, exurban, or rural context presents a host of issues that emanate from these settings. Sprawl and the character of development affect the way people use the built environment for physical activity.

3. USING THE ANALYTIC FRAMEWORK

The intent of our research is to provide information about community conservation plans, programs, and projects on parks and recreation. Our research provides an ontologically coherent framework for analysis of design and planning strategies that encourage active living. It is therefore essential that the key stakeholders, and professionals such as land regulators, planners, and designers, benefit from practical applications of the methods, design criteria, and performance standards resulting from this study. To this end, our comprehensive framework includes four critical areas that impinge on active living: profile of the people, assessment of the built environment, assessment of parks and recreation, and partnerships and management.

3.1. IDENTIFYING KNOWN VARIABLES

The outcomes of this study were achieved in two phases. The first phase collected data, which included the local and regional context (historical, cultural, environmental, transportation); related plans and studies; demographic profile of the study area, including residents’ physical activity levels; built environment issues including sprawl, zoning, and pollution; parks and recreation characteristics, including park types, scale, naturalness, location and access, diversity of uses, and facilities; and management structures, partnerships, and stakeholders. Phase I also identified issues in the Pottstown region within the scales of the framework, which entailed not only understanding the region as a whole, but also comprehending the needs of its multifarious communities (Figure 1). The four elements of the analytic framework (graphically illustrated in Figure 2) translated into broad types of data collection and analysis, categorized as follows: the built environment, people, parks and recreation, and partnerships and management. Various sources for data collection were used, including: census databases, regional reports, GIS-based maps, and on-site observations. As information was compiled, it became clear that particular components of the framework had no available data—most notably absent was data on behavioral factors influencing physical activity.

Phase I concluded with a comprehensive plan for obtaining the missing data. Interviews with stakeholders, telephone surveys, and focus groups helped frame the behavioral patterns of the community in relation to active living. This and the previously mentioned data filled in the analytic framework. It was determined that certain variables affecting active living had not been fully considered by the Pottstown community—these areas became the targets for improving the community’s parks and recreation systems (as illustrated in Figure 4).

3.2. DEVELOPING GUIDELINES

The second phase linked findings and conclusions from Phase I research to planning objectives, issues and characteristics, recommendations, and implementation strategies. Based on data collected from focus groups of stakeholders and end users, Phase II culminated in guidelines regarding development strategies for the built environment and parks and recreation system. These guidelines influence variables that are not currently considered in relation to active living. As such, these variables are the untapped potential for improving active living within the community. The method for these guidelines consisted of an evaluation of key behavioral factors for park visitation and active living, an assessment of the “well roundedness” of parks, and the identification of models for planning parks systems. In general, the process can be summarized as follows:

Planning Objectives:

Planning objectives can be defined as the most fundamental tools underlying all planning, design, and strategic activities. To this end, a set of “planning objectives” or guiding urban design principles is articulated, which guide strategies for promoting active living through parks and recreation systems.

Issues and Characteristics:

This part comprises an explanation of the planning objective and its significance, including a brief discussion of the problems to be resolved in order to provide a broad context for the planning objective. A clear and concise description of the essential qualities and characteristics the environment should possess to resolve the identified problems. The description is broad and evocative, but has a certain degree of specificity.

Recommendations:

These are statements that suggest relevant planning or design strategies for resolving or alleviating the identified problem(s) in order to achieve a desirable or essential environmental outcome.

Implementation Strategies:

This section consists of descriptions of opportunities for improvement that provide actionable strategies for implementation if applicable.

The analytic framework allowed the articulation of planning objectives, issues, and recommendations on the nature of the built environment in that impinge on the parks and recreation system and active living. These related to a number of larger regional issues such as prevention of sprawl land loss, creation of integrated networks, and alleviation of environmental concerns.

Many issues related to partnerships and organizational structures, as well as impediments to collaboration among municipalities or community organizations in the study area, were integral parts of the research.

The framework was used to produce viable strategies for the parks and recreation system in the region at multiple scales—neighborhood, community, and region. Figure 4 highlights how the process of generating guidelines functions within various scales of intervention. In the end, the analytic framework identified positive assets for each community and opportunities for promoting active living, delivering a set of guidelines that local policy-makers can easily institute.

The analytic framework provided a background and the context for planning objectives, recommendations, and implementation strategies for the parks and recreation system in the study area. The planning objectives provide a tool kit capable of application to any municipality within the study area. The validity of the framework resides in the fact that immediate action can be taken on any or all issues. The approach covers the following key topics:

- A review of the literature on parks and physical activity, including a discussion of the importance of well-rounded parks.
- An overview of four key behavioral factors, which describe the choices people make related to park visitation and physical activity.

- An explanation of the parks assessment tool developed during the course of this study. This tool assesses well roundedness in parks according to four primary categories of opportunities: physical activity; contact with nature; social connections; and connections with history, culture, and sense of place.
- Three models for parks systems: the walkable network; well-rounded destinations; and a blended approach. Each model is appropriate for different densities of the built environment, and takes into account people's behavioral choices. This part also provides information on specific actions and parks to be improved.
- Guidelines for planning at the system level and design guidelines specifically applicable to individual parks. These guidelines are intended to be taken into consideration during the planning and design phases of implementing the models for parks systems.

It is beyond the scope of this paper to delve into a detailed discussion and analysis of the guidelines that resulted from this analytic framework. Figures 3 and 4 delineate the planning and design objectives derived from this approach that formed the basis for our recommendations and implementation strategies. Suffice it to say that these guidelines are essential to influence changes in behavior at multiple levels—ranging from the intrapersonal to the policy levels—in order to enhance active living through the parks and recreation system in the Pottstown Area.

CONCLUSION

While there have been many attempts to address the critical concerns of the region, a comprehensive and shared understanding or strategy is still lacking. An emphasis on the relationship between built environment and active living is singularly lacking in current research and studies. Environmental and policy interventions have been identified as the most promising avenues for creating widespread improvements in physical activity, eating habits, and weight status. The analytic framework of this study proposes an interdisciplinary and multi-level approach to promoting active living lifestyles consistent with ecological principles.

The framework targets domains that have implications for the built environment. As represented in the conceptual model, active living includes a wide range of activities. The concept of active living allows for a deeper understanding of physical activity and shifts the emphasis from solely exercise to the manner in which physical activity is perceived. The built environment has the potential for a strong impact on active living and can facilitate or constrain physical activity. Providing the necessary infrastructure that supports active living behavior through parks and recreation planning is of paramount importance.

The analytic framework of this study was developed to allow relevant domains of active living to be examined within the context of distinct behavior settings, planning strategies, and policy environments. The identified behavior settings under investigation exist within the neighborhood and recreation environment. Ultimately, the intent is to provide information related to the development of community conservation plans, programs, and projects on parks and recreation. It accomplishes this by providing new insights into community plans encouraging active living.

Based on the initial response to the outcomes of this research, it has become clear that land regulators, planners, and designers will benefit from practical applications of the methods, design criteria, and performance standards suggested by the study. When incorporated in policy documents, they could offer insights into development strategies for active living in similar towns in Pennsylvania. Our comprehensive analytic framework, which includes four critical areas that impinge on active living: profile of the people or the community, assessment of the built environment, assessment of parks and recreation, and partnerships and management structures, will yield fruitful data for future research and allow further refinement during the implementation process.

When dealing with the complexity of issues involved in this research, some concerns could not be fully addressed as conceptualized in the analytic framework and warrant further study. For instance, given the enormity of the planning and design process for encouraging active living through the parks and recreation system in the study area, many budget and equity issues for various municipalities

were not fully tackled. These issues have significant implications for not only partnerships and management structures in the area, but also for planning and development strategies. In this context, it would be worthwhile to continue investigating these issues and develop compelling strategies for municipalities to merge or consolidate resources more effectively.

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Regenerative Suburbanism: LIRR Long Island Radically Reconsidered

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ABSTRACT:

This paper presents the author's design research on suburban sustainability, developed in collaboration with Ana Serra, Katelyn Mulry and Sven Peters. Our entry "LIRR Long Island Radically Rezoned" was selected as one of 7 winners of the 2010 'Build a Better Burb' ideas competition and won first prize in the D3 Natural Systems international design competition 2010.

Current paradigms of sustainability such as efficiency and conservation are merely slowing down but not preventing the process of resource depletion and environmental degradation. A more ambitious approach is required: Regenerative design integrates processes that are conducive to renewing sources of energy and materials, creating closed loop systems that fulfill the needs of society while preserving the integrity of nature. Regenerative design is the biomimicry of ecosystems aiming to create optimized, holistic frameworks for systems that are absolutely waste-free. We have studied Long Island, NY for its potential to become a regenerative region.

Long Island's most unique and defining condition is that of containment and the island itself – a spatial entity unable to expand beyond its own footprint. By conceptually capitalizing on this 'insular' condition we developed our Living Island proposal, applying closed loop principles on a macro scale: water, energy and waste neutral and 100% local food production.

By drawing on the metabolism of the island to provide a regenerative natural environment and to create synergies between the various resource streams the current administrative structure is eliminated in favor of a 'proximity-to-mass-transit' based subdivision. The variations in existing density and frequency of train stations create an organic and supremely functional land use pattern – the Smart Cells.

Capitalizing on the densification potential of the downtowns, the perimeter of each Smart Cell will be re-naturalized overtime as residents move into the newly developed downtowns, ultimately creating a continuous restorative fabric for recreation, agriculture, and ecological corridors.

CONFERENCE THEME: Approaches

KEYWORDS: Regenerative design, suburban sustainability, densification, renaturalization, closed loop thinking

I. INTRODUCTION

This paper presents the author's design research on suburban sustainability, developed in collaboration with Ana Serra, Katelyn Mulry and Sven Peters. It was selected as one of 7 winners of the 2010 'Build a Better Burb' ideas competition¹ and won first prize in the D3 Natural Systems international design competition 2010².

2. A REGENERATIVE VISION FOR A LIVING ISLAND

Current paradigms of sustainability such as efficiency and conservation are merely slowing down but not preventing the process of resource depletion and environmental degradation. A more radical approach is required: Regenerative design integrates processes that are conducive to renewing sources of energy and materials, creating closed loop systems that fulfill the needs of society while preserving the integrity of nature. Regenerative design is the biomimicry of ecosystems aiming to create optimized, holistic frameworks for systems that are absolutely waste-free.

Applying these principles on a regional level in the US will result in a fundamental restructuring of our predominantly suburban territories. We have studied the aging suburban fabric of Nassau and Suffolk Counties on Long Island, NY for its potential to become a regenerative region. Sixty years after William Levitt built his first subdivision on the potato fields of the Hempstead Plains, Long

Island once again will serve as a testing ground for new settlement patterns (Fig.1).

Long Island's most unique and defining condition is that of containment and the island itself – a spatial entity unable to expand beyond its own footprint. By conceptually capitalizing on this 'insular' condition we imagined Long Island as a 'Living Island', applying closed loop principles on a macro scale: water, energy and waste neutral and 100% local food production – a completely self sufficient and waste free island.



Fig. 1: Aerial View of LIRR Long Island Radically Rezoned

3. SUBURBAN SELF SUFFICIENCY

The concept of self sufficiency is indeed a radical notion for suburbia, a settlement typology that was never meant to stand on its own, but rather was conceived as a mere extension or supplement to the metropolitan condition. Enabled by increasing advances in transportation infrastructure (first horse carriages, then trains, then freeways) people could work in the big city but were able to live outside its overcrowded neighborhoods, in romanticized versions of the cabin in the woods with the luxury of space.

Contemporary suburbia however can no longer be understood as the antidote to the metropolis. Today Long Island, like many other suburban regions, is facing several pressing social and environmental issues. Increasing traffic congestion, urban sprawl, depleted aquifers and storm water runoff are just some of the environmental problems, threatening both the balance of the eco systems as well as the health of its inhabitants and the socioeconomic structure of the communities. The lack of walkable communities with affordable housing options, diminished viability of small businesses due to higher taxes as well as increased social inequity started to erode the social fabric and created blighted conditions more commonly associated with urban inner city neighborhoods. The concept of increased quality of life by living in close contact with nature with ample access to light and clean air has long been lost since most of the natural landscape has disappeared under a sea of asphalt for roadways and parking lots. Suburbia's last vestige of nature, the infamous front lawn, consists of non-native vegetation requiring regular input of chemical pesticides and large quantities of water to be maintained.³

Some of the answers to these problems can be found by looking into the past, at Long Island's prewar landscape of compact small towns connected by mass transit, a settlement pattern that has been largely ignored since the postwar boom. Unlike other, more recently developed suburbs, Long Island is blessed with the existing mass transit infrastructure of the Long Island Railroad, already the busiest

commuter railroad in the country⁴ with the potential to once again become the infrastructural backbone of the island.

Many of the social and environmental issues of suburbia are linked to the excessive land use of suburban sprawl. Long Island's density is 30 times lower than that of Manhattan. Suburbia can no longer be understood simply as a residential extension of the city and therefore needs to generate its own economic viability. This will most likely be achieved by creatively retrofitting its downtowns and introducing urban characteristics such as density, proximity to services, programmatic diversity and efficient mass transit. Long Island will be learning from Manhattan.

Lastly, Long Island has the opportunity to fundamentally rethink or rather rediscover its relationship with nature. The relatively low density of suburbia coupled with the densification potential of the downtowns present a unique opportunity to reintroduce large amounts of open space to the island and yet increase its overall population capacity.

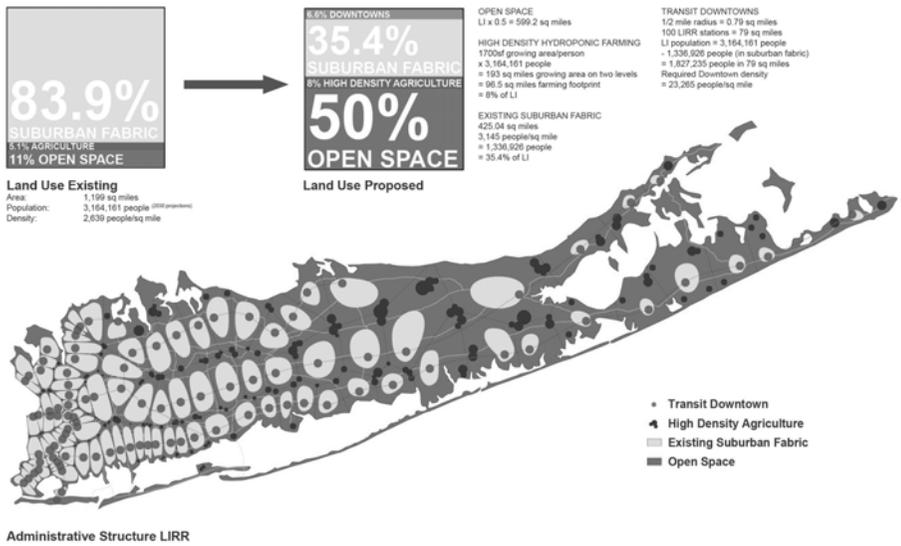


Fig. 2: Land Use and Density Proposal

4. LAND USE AND DENSITY PROPOSAL

4.1 OPEN SPACE (50%)

Currently only 11% of Long Island is designated as protected public open space while the rest is covered in a continuous suburban fabric. Over the past years Long Island has continuously fallen short of the open space preservation goals outlined by the Department of Environmental Conservation⁵ and final build out of the island is expected to take place within the next decade⁶.

In order to create a balance between manmade and natural systems, which have the potential to offset the human footprint, we propose a radical rezoning of Long Island by assuming that for each unit of developed land we would set aside an equal amount of open space for habitat restoration and ecosystem services, creating 600 square miles of re-naturalized open space, bringing back long-lost local ecosystems such as the native grasslands of the Hempstead Plains – once one of the few true prairie landscapes on the East Coast⁷ (Fig.2).



Fig. 3: Smart Cells

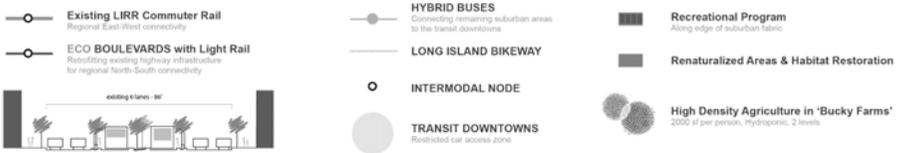
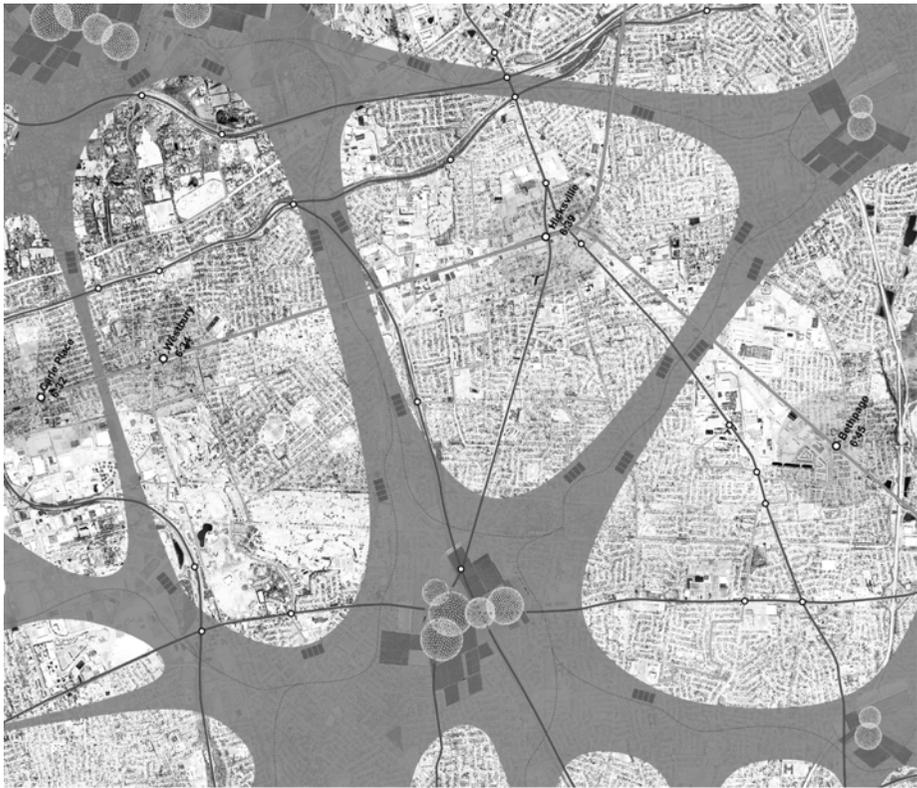


Fig. 4: Transportation Infrastructure

4.2 AGRICULTURE (8%)

There is a long history of farming on Long Island and this can be optimized; we propose 95 square miles of high density hydroponic farming on two level structures which would enable us to grow all food for all Long Islanders locally⁸. Food would be grown in indoor farms under light weight, ETFE plastic covered dome structures - we have named them Bucky Farms - which would be distributed across the island, clustered within the re-naturalized open space areas alongside green utilities such as waste and water treatment facilities. The farms double as 'digesters' of organic waste (the majority of household waste) which can be used as soil amendment and compost, solving part of the growing waste problem as well.

4.3 MIXED-USE DOWNTOWNS (7%)

Absorbing the population from the re-naturalized areas into the downtowns requires a downtown density of approx. 23,000 people per square mile⁹. Even though this is almost 10 times the existing overall LI density, it is only about 60% of the average density of Brooklyn¹⁰.

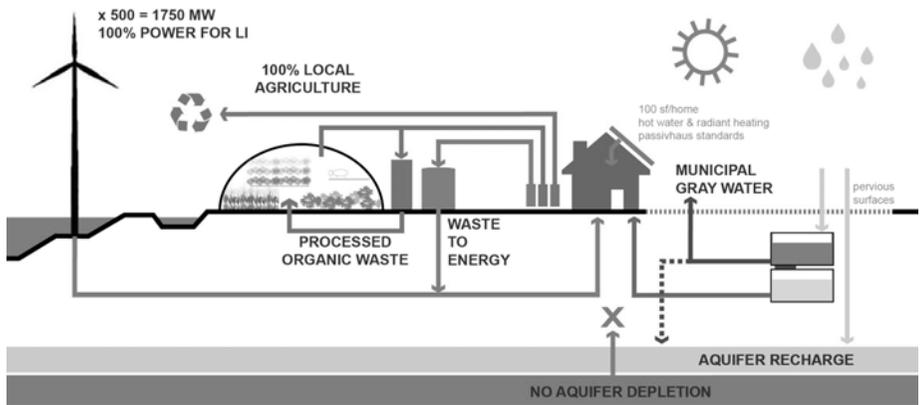


Fig. 5: Regenerative Strategies Diagram

4.4 EXISTING SUBURBAN FABRIC (35%)

We further assumed that the remaining suburban fabric outside the downtown areas would not be densified, in order to maintain the existing suburban lifestyle for those not willing to live in higher density.

5. RESTRUCTURING

5.1 SMART CELLS – TRANSIT-BASED LAND USE LOGIC

The organizing and restructuring of the proposed land use is based on the Smart Cell logic. While the existing spatial organization of Long Island is largely based on the automobile, we imagine the Radically Rezoned Long Island as one that is based on transit infrastructure. By appropriating a geometric logic found in nature and defined by the Voronoi diagram (Fig.3) the locations of the 100 existing Long Island Railroad stations within Nassau and Suffolk Counties are used to generate a new polygonal subdivision pattern based on proximity to mass transit – the Smart Cells. The perimeter of each Smart Cell – the areas furthest away from a train station - will be re-naturalized overtime as residents, encouraged through tax incentives and a healthier, more social lifestyle, will move into the newly developed downtowns. Over time this process will create a restorative connective fabric for habitat, recreation and agriculture, a 50/50 balance between nature and man-made. Variations in existing population density and location of train stations create a very organic and supremely functional pattern (Fig.4). More than just a new land use logic we imagine the Smart Cells as a

new transit-based administrative structure for the island, replacing the fragmented and inefficient jurisdictions of today.

5.2 TRANSPORTATION:TOWARDS 100% CLEAN ENERGY

The existing network of the Long Island Railroad was designed as a spoke and hub system, providing excellent East-West connectivity between Long Island and New York City, but providing no North-South connections within the island. This is symptomatic of the view of suburbia as an extension of the city and a different understanding of suburbia will require a different transportation model. To provide the required north south connectivity we propose to repurpose some of the island's existing car-based infrastructure into 'EcoBoulevards' with reduced car lanes, light rail and a system of bio swales for storm water management and natural treatment. Along with a hybrid bus system to connect the remaining suburban fabric to the downtowns and an extensive bike trail network within the re-naturalized areas, a transport infrastructure based on 85% clean fuel can be implemented, with the remaining 15% from cars likely transitioning towards clean and hybrid vehicles through new, increasingly affordable technologies, incentives or tax benefits (Fig.4).

5.3 RENEWABLE ENERGY

Through implementation of rigorous retrofitting energy efficiency standards to first significantly reduce existing demand and solar thermal technology for all existing and new buildings the electricity demand will be reduced to the extent that an array of 500 offshore wind turbines along the Long Island's south shore will create enough electricity to supply all of Long Island (Fig.5). Though ambitious in scale this would be an extension of a project already under way .

5.4 ZERO WASTE TO LANDFILLS

A closed waste stream loop would be implemented in which glass and metals would be recycled, organic waste (including paper and plastics) would be turned into energy in a waste-to-energy plants or soil amendments and compost for agriculture¹¹.

5.5 WATER NEUTRAL

A significant amount of LI's water is used for irrigation. After significantly reducing demand through smart irrigation technologies and use of native or adapted grasses and vegetation we will be able to meet all water demand by capturing only 6% of the rainwater that falls on Long Island^{12 13} . Long Island's stressed aquifer will not only not be further depleted but recharged by significantly reducing the amount of pervious surfaces. Waste water will be treated and reused as grey water, for irrigation, distributed through a public grey water network.

6. DOWNTOWN REVITALIZATION STRATEGIES

In order to achieve the required density of the downtowns and to revitalize vacant areas, we developed several urban typologies and tested them on the example of Hicksville's downtown, a hamlet located within the Town of Oyster Bay in Nassau County (Fig.6). Rather than creating density by imposing an urban model of high rise apartment buildings we were looking for ways to achieve density while maintaining essential suburban qualities. On the most basic level we believe that this means primarily four things: low rise construction with a maximum of three stories, individuality (for example in the form of a ground floor entrance directly off the sidewalk), privacy (especially a private outdoor space directly attached to the residence) and access to light and nature. Successful built examples such as Siedlung Halen in Switzerland¹⁴ or Borneo Sporenburg in the Netherlands¹⁵ demonstrate that substantial density can be achieved while observing these parameters.

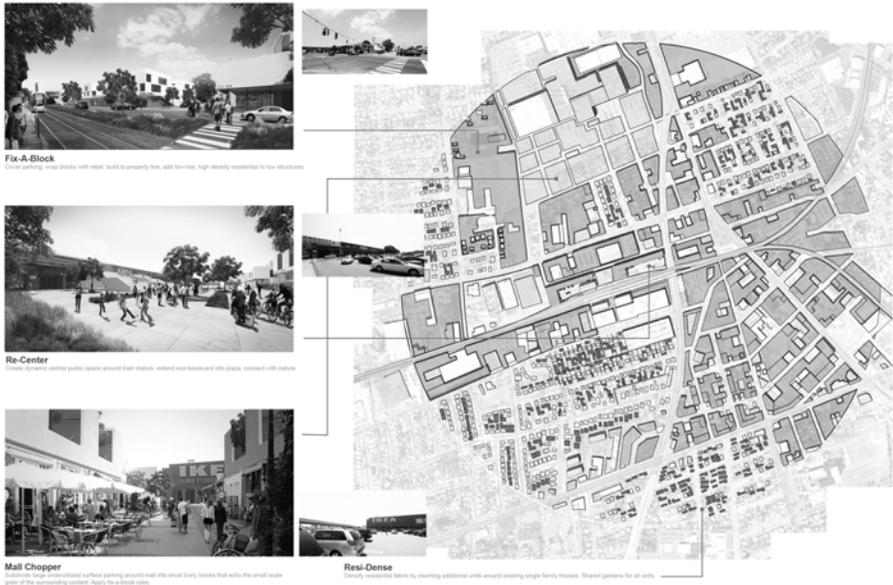


Fig. 6: Urban Typologies for Downtown Revitalization

6.1 FIX A BLOCK

Even though Hicksville downtown has a street grid and block structure it is virtually non-existent spatially, since the majority of the downtown blocks are given over to surface parking for LIRR commuters. This lack of public space definition along with the absence of civic and commercial programs to generate activity makes for a pretty dead public life. Our first strategy “Fix A Block” aims to remedy this condition: the blocks are being wrapped with a one story liner of public and retail program built to the lot line, parking continues to be provided in form of a covered parking structure in the center of the block and a carpet of low-rise, high-density housing with private outdoor spaces is layered on top.

6.2 MALL CHOPPER

The same typological approach is employed on the large underutilized surface parking areas surrounding shopping malls which are subdivided into small blocks that echo the small grain of the surrounding context.

6.3 RESI-DENSE

In order to densify the existing residential fabric within the downtown area, additional units are inserted around existing single family homes, carefully negotiating the requirements of privacy, individuality and access to light and nature of both the existing as well as the new residences.

6.4 RE-CENTER

We believe a central civic space is an important ingredient for a successful downtown revitalization. In our proposal this new vibrant downtown ‘piazza’ is centered around the train station, celebrating transit and creating an extension of the public space of the Eco Boulevard thus connecting the train station to civic life. The surrounding buildings would have a slightly higher density and consist of more urban residential typologies that could be used as college dorms and for intergenerational or assisted living.

7. THE TIME FOR CAUTIOUS THINKING IS OVER

Even though this proposal to radically rezone Long Island may seem utopian in its scope, it is completely feasible from a technological point of view and we believe that it would significantly improve the quality of life for all Long Islanders.

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100 LIRR stations = 79 sq miles
LI population = 3,164,161 people
- 1,336,926 people (in suburban fabric)
= 1,827,235 people in 79 sq miles
Required Downtown density
= 23,265 people/sq mile
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Research into drawing and building

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ABSTRACT:

This paper introduces two case studies of the role of representation and specifically drawing in the process of designing buildings. These case studies are Notre Dame du Haut at Ronchamp by Le Corbusier and All Saints Church in Brockhampton, England by William Lethaby. The described investigations are preliminary case studies whose goal is to establish a methodology for a larger body of research concerning the use and role of drawing in architectural practice and theory in different moments in time. This research will lead to examining nature of architectural representation and its influence on the current condition of architectural thought and practice.

CONFERENCE THEME: On Approaches

KEYWORDS: Archives, Drawing, Building, Representation

INTRODUCTION

This paper is the result of a research project that was funded by a Scholarship and Creativity grant awarded by Montana State University and conducted in the summer of 2008. It analyzes two preliminary case studies of the role of drawing in the process of architectural design and its influence on the constructed building that is a result of that design process. Buildings chosen for these case studies are Notre Dame du Haut at Ronchamp by Le Corbusier and All Saints Church in Brockhampton, England by William Lethaby.

These two explorations are conceived as preliminary studies for a series of further investigations that will share the same or similar methodology and will result in a wider and more comprehensive body of research which will focus on the study of the relationship between buildings and their representation and on the role of that relationship in the shifts in theory and practice of the discipline of architecture. The primary goal for the two preliminary studies described in this paper is to develop a methodology that will be then employed in the remaining case studies.

I. THE QUESTION OF ARCHITECTURAL REPRESENTATION

The relationship between building and its representation is essential to architectural practice. As Robin Evans said architects do not make buildings, they make drawings of buildings. (Evans 1997) For the past few hundred years, the basic task of an architect has been to imagine, visualize and represent a building to be built. Throughout the creative process of design the architects have used different kinds of drawings to communicate and manifest different ideas about the building to themselves and to others. At the end of this process the architect produces a set of drawings which describes the final design of the building and constitutes a set of instructions for others to follow in construction of the actual building. Thus, drawing as a tool for communicating either with oneself or with others is a crucial element of architectural practice.

In recent years many architectural critics and scholars have shown a strong interest in various aspects of architectural representation. People such as Alberto Perez – Gomez, David Leatherbarrow, and Robin Evans (Perez-Gomez 2000, Leatherbarrow 1998, Evans 1997) have focused their attention on understanding the nature of architectural drawing – in history as well as in the present – and its relationship to the built building. The reason for architectural representation becoming the

subject of architectural research in the past decade is that the relationship between drawing and the building is right now at the critical moment of its development. The advance in digital technology in drawing, modelling and fabrication has brought architectural practice, as we know it, to the point of radical change. All the modelling software such as 3DMax, Rhino, Form Z and tools such as CNC (computer numerical control) machines and 3D printers allow for creating visual / digital representation of an object (such as building) and then direct production of that object without involvement of another human being. Thus, the new software and tools focus on eliminating the gap between the process of drawing an object and the process of building that same object. That means that one of the crucial moments of interpretation, translation and communication between the designer and the builder, between the drawing and building, is eliminated.

This kind of change in the creative process of designing and building is so radical and so crucial to the profession of architecture that it brings to mind a comparison with the processes that were initiated by the Renaissance appearance of the widespread use of architectural drawings, such as plans, sections, elevations and most of all perspective. Until that moment the work of the architect was synonymous with that of the builder. Since the architect and the master builder did not have sufficient tools to imagine and visualize the building and its space ahead of time, the building was designed as it was being built. The way that the builders communicated with each other was through sets of geometrical rules and instructions that were memorized and applied to the layout and the façade of the building or through full size templates used in the tracing shops for design and repetition of specific parts of the building. (Fitchen 1961) Thus, before the Renaissance there was no actual distinction between the process of design and the process of building. With architects visual imagination empowered by the renaissance linear perspective they were now able to use those and other architectural drawings – plans sections and elevations as tools for finalizing and presenting their designs on paper and prior to the beginning of construction. Since the architect was now able to communicate with the builder with a substantial degree of precision he was also able to remove himself from the physical process of building. Thus, the use of drawings – roughly the same as architects have been practicing until now, allowed for the work of the architect to be separated from that of the builder and allowed for the profession of architecture to become its own independent entity

Digital technology is today employed in almost every architectural office and all architecture students learn how to use digital modelling and fabricating tools. Quite often though the fascination with the efficiency, smoothness and the “coolness” of the new media leaves us blind to its real cultural implications.

I believe that taking part in that moment of radical change puts us in a position that has advantages and disadvantages at the same time. The disadvantage is that being intimately engaged in the changes that are taking place we do not have enough space and objective view to be able to really understand what is happening. The advantage of our position is in witnessing the end of an era and in being able to look in an analytical but still intimate way at the condition that has been established for quite a while and is just about to fundamentally change. I believe that understanding what the creative process of designing and producing a building has been until now will bring us closer to understanding the changes that are taking place at the present moment and it will make it possible for us to be conscious of our place in that moment of change in architectural practice.

2. PRELIMINARY CASE STUDIES

2.1. SIGNIFICANCE OF THE CHOSEN BUILDINGS

The overarching research project whose part is described in this paper (two of a series of case studies) focuses on a number of specific moments in the history of architectural practice and thought where the moments of change can be recognized by the change in the established conventions of the architectural representation. Thus, the shift in the use of architectural drawing indicated and manifested the change in architects’ thinking about space and construction. These case studies will establish a context for the examination of the current condition that I described in the first part of this narrative.

These moments include:

- The early use of drawing in the Renaissance which I mentioned and which caused the split between the profession of architecture and building,
- The 19th century and the Industrial Revolution which resulted in complete change of the means of production as well as in development of the descriptive geometry which in turn immensely influenced the precision and objectivity of the architectural drawings,
- The peak and the end of the Arts and Crafts movement when the skills and the pride of the craftsmen allowed for a very unique communication between the architect and the builder,
- The peak of the modern period in architecture

This paper focuses on two preliminary case studies and explores the creative processes leading to the design of two buildings similar in type, size and scope but conceived and completed in different times and as parts of different movements. These buildings are: All Saints Church in Brockhampton, Herefordshire, England (1902) by William Lethaby and Chapel of Nôtre Dame du Haut in Ronchamp, France (1955) by Le Corbusier. (figures 1 and 2)



Figure 1: Chapel at Ronchamp



Figure 2: All Saints Church in Brockhampton, England

I chose these two buildings because they both represent moments of change in different design thought continuums.

Brockhampton church was designed and built at the peak of the Arts and Crafts movement where all creative endeavours were rooted in the craftsman, and builders taking full pride in their work. That meant that the architect could leave parts of the building design (such as details) off his drawings and still expect them to be done properly and at high quality – according to the craftsman's learned and inherited knowledge. Lethaby on his part was also known for believing strongly in bringing together design and production. Such belief on the part of the architect together with the building culture of the times must have resulted in the architect producing a set of drawings that was very specific for that particular moment in time which is definitely now gone.

When Le Corbusier designed Ronchamp Chapel he was one of the most famous architects in the world. He had a lot of experience in designing buildings as well as in seeing them built. I chose this building for my research project because it was a building that was very different from every other project done by the same architect. Its form and in result the space enclosed by the forms, were not governed by strict geometrical rules. They rather seem to be free flowing and soft. Thus, Le Corbusier needed to employ the tools that he had already mastered more than anyone else and was very familiar with to develop and communicate form and space that was not familiar to him and what's even more important it was new to the builder and client.

2.2. METHODOLOGY

Both studies were initiated by visiting archives that hold the original drawings produced for both buildings - the Le Corbusier Foundation and the archives of the Royal Institute of British Architects - and examining these drawings. Both buildings were then visited directly after the archives in order to discover the subtleties of the relationship between the drawings and the buildings. Conclusions were then drawn in regards to the role of different kinds of drawings in the process of design as well as their manifestation of different aspects of architectural thought and its influence on architectural practice.

Examining original drawings created for each building is crucial in this method of investigation. In both cases it has been important to understand the medium, the size and the overall tangible quality of the drawings. Different kinds of drawings created by architects, especially when they are created by hand, become a personal and somewhat intimate signature. Through examination of that drawing, and even more so a series of drawings, one maybe able to read the process of thinking, designing and production. This kind of intimate and tangible quality is lost in the case of drawings created with digital media.

In order for both case studies to be comparable I chose to examine a similar series of drawings in each case. I looked briefly at the entire holding of the archives and chose a few drawings in each case that represented the process of design from the inception of the concept, through development of the design to drawings used for construction. I then examined these chosen drawings carefully in order to develop an understanding of the process itself.

There were significant and immediate differences noticeable between both buildings and both architects. The Le Corbusier foundation holds a very complete collection of a few hundred Ronchamp Chapel drawings. These drawings are not available to be examined in person, but they are scanned at very high resolution and available to be seen on a computer screen. This mediation through the screen does not allow for the actual tangible contact with the drawings. It is quite difficult to understand the texture of the medium used and to really, physically understand the size of the drawings – the sizes are given in numerical terms, but having the size in terms of numbers is very different than being confronted with the actual drawing and its size and material. On the other hand the high quality of the scans makes it possible to understand the lines, strokes and in some ways the texture of the drawings. It is also possible to enlarge details and see them more “up close”.

The way of examining the drawings by William Lethaby, produced for the All Saints Church that are held at the Royal Institute of British Architects archives was very different. I was able to look at each drawing, in its original and tangible form, directly and in person, without any mediation. I was

able to relate to each drawing's size and texture. However, there were only 12 drawings that were held in the archives.

2.3. DRAWINGS FOR NOTRE DAME DU HAUT AT RONCHAMP

Drawings for the Chapel at Ronchamp were done by Le Corbusier's office, which means that only a few of them were produced by Le Corbusier himself and others were approved by him while produced by someone else.

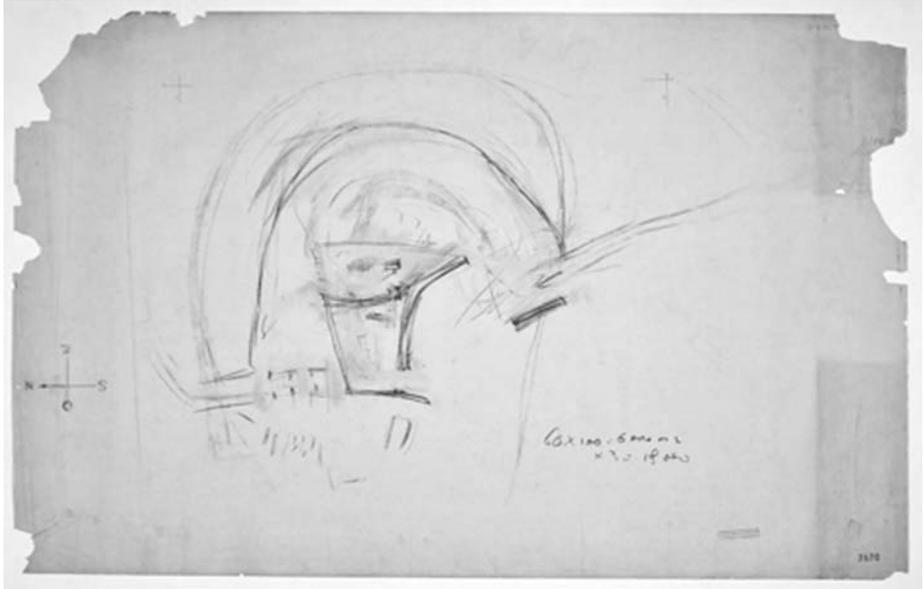


Figure 3: Charcoal sketch by Le Corbusier (Le Corbusier Foundation , Paris)

The early sketches that were done by Le Corbusier in the very initial stages of design, and especially the charcoal sketch that was done on June 6 1950 (figure 3) establish the overall form and quality of the building. The sensual, textural quality of form and light that is very strongly present in the building is already present in this charcoal sketch. The general form of the plan of the constructed building is already delineated in this sketch.

The plan's four lines are indeed a response to the site; they are two curves opening up onto a vast landscape and designed to receive the pilgrims; two straight lines that rejoin them and close the figure. (Pauly 1983, 55)

The lines that respond to the different horizons and would eventually become the basis for development of different facades are there and so are the spatial qualities of all four sides of the building. Thus, the spatial engagement of the exterior of the building is already embedded in the curvature and texture of the charcoal line. I believe that there is a specific, physical way in which that spatiality had been embedded in this drawing and then consequently in the building. That reason is the medium and dimensions of this drawing. This drawing is 75cm by 118.5 cm (30 inches by 46.5 inches) large. That is large enough for one to be compelled to engage his or her body, beyond the wrist or even elbow in making this drawing and especially in drawing the continuous lines of the four facades. It seems to me that such bodily engagement with a drawing must result in the drawing taking on the spatial qualities associated with a human body. This feeling of body's engagement in the drawing is further emphasized by the softness and messiness of charcoal. A line made with charcoal has a very distinct texture and light to it. In addition these lines are easily erased and smudged. It is clear that the lines made by Le Corbusier were smudged, erased and redrawn a few times. This process gave

the drawing not only multiple layers of information but also physically multiple layers of charcoal powder on the paper, which gave additional ambiguity to the drawing. Daniel Herbert discussed this drawing in depth. He spoke of in the context of the conventions of architectural drawing:

for early study drawings it is assumed that conformance to conventions is less rigorous than for later drawings; lines are assumed to be both ambiguous and mutable. ... He (Le Corbusier) assumes that all these lines are ambiguous and mutable in that he may interpret or ignore any line, or add new lines in this or subsequent drawings. (Herbert 1993, 59)

If one compares this sketch, which was the first physical manifestation of the Ronchamp's space with a section of the building one can notice that these two drawings have many similar attributes. The spatial qualities of the plan found their continuation in the section. And again, what seemed to be so striking in experiencing the building, the continuous but not direct relationship between the space of the exterior of the building and its interior, is also embedded in the sketches that started the design process. This drawing is not simply an image of the future building but it has experiential qualities itself.

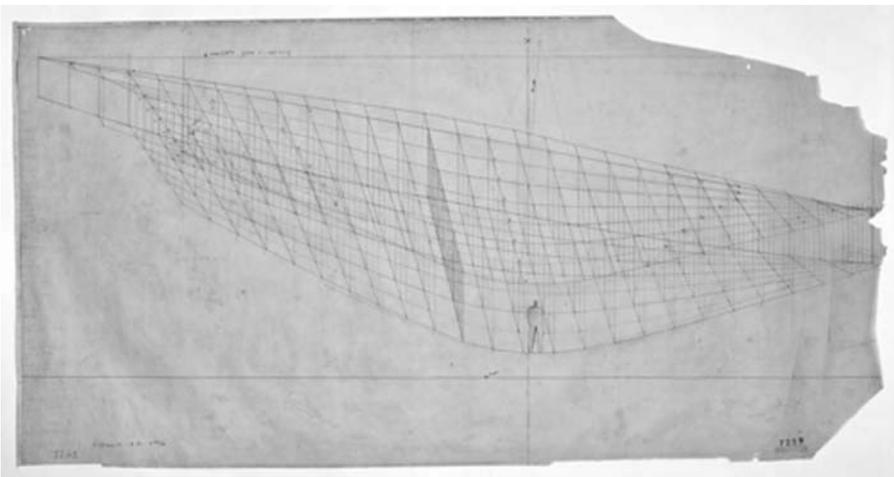
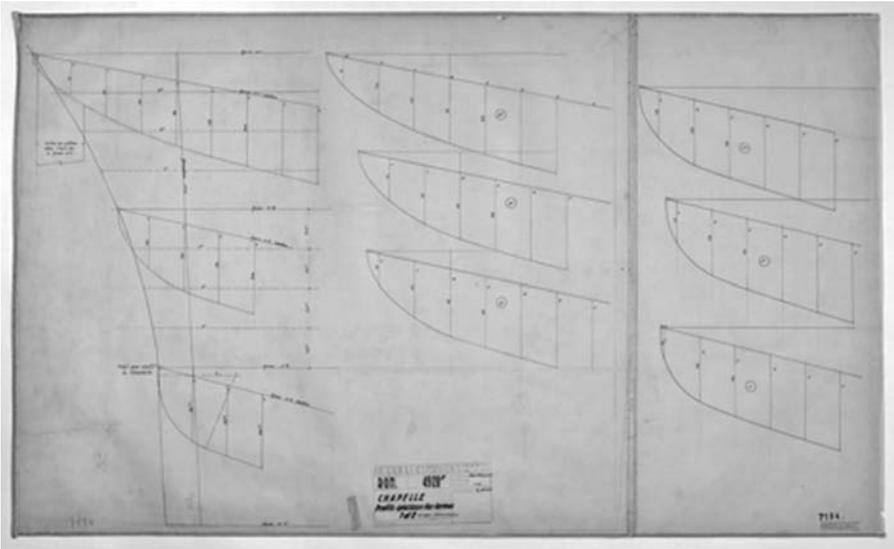


Figure 4 and 5: Analytical drawings of the Ronchamp Chapel's roof (Le Corbusier Foundation, Paris)

Two drawings that were also in the group that I chose to examine, and that I would like to position in contrast to Le Corbusier's early charcoal sketch discussed above are the analytical drawings delineating the form of the roof. These two drawings are examples of a whole series of drawings prepared by the architect's office that reveal the exactitude and authority of each physical element of the building. Both of these drawings show development of the roof and both of them approach the roof not as a sensual form (as it is seen in the sketches) but as a accurately defined geometrical and mathematical volume. The first drawing (figure 4) is a study of multiple profiles of the edge of the roof. The roof is sliced and taken apart in order to give it specificity and exactness. The second drawing (figure 5) takes that information and assembles it. It shows a precisely developed three-dimensional mesh of the roof's volume. These drawings are of course drafted with very precise pencil lines; they do not show shadow and texture, they show the precision of surface. However, there are two aspects of the mesh drawing that relate it directly to the experiential nature of the building. The first one is the modular man drawn within the volume of the roof which reveals the study of the volume's proportions in relation to human body. The second are the lines that define the surface of the roof. They predict the lines that the concrete formwork will leave on the underside of the finished roof. These lines are very noticeable in the building as they give strong spatial sense to the interior portion and curvature of the roof in the building.

Looking at the series of drawings representative of the process of design of the Ronchamp chapel, one can see a very clear contrast between sketches done by Le Corbusier himself as well as textured and shaded elevations which are partially drafted and partially sketched and highly analytical series of sections and axonometric drawings which very precisely and accurately define the actual form of the major elements of the building such as the roof, walls and towers. Considering that Le Corbusier was designing the chapel but not building it, these "irregular" forms had to be described very carefully in order to communicate clearly to the builder. I believe the active use of these two kinds of drawings throughout the design process where the extremely disciplined and accurate drawings of forms are developed by the office in response to the experientially rich drawings done by Le Corbusier set up a tension which was the driving force of the process of design and which is now present in the building itself.

This tension is between the softness and organic quality of the forms, textures and light and the mathematical exactitude of the forms and surfaces. The visitor's mind oscillates between the two different understandings and experiences. I think that this oscillation is at the root of the experience of Ronchamp's space.

2.4. DRAWINGS FOR ALL SAINTS CHURCH IN BROCKHAMPTON

Drawings developed by Lethaby for the Brockhampton Church proved to be quite different and they revealed a very different process of design. The tangible and tactile quality of these drawings was striking. The majority of them were done on highly textured paper with use of drafted line and watercolor poche. All the drawings that I examined have the same quality as they were done either by the same person or by few people working closely together. These drawings are quite heavily annotated with notes, sometimes in red, which were clearly added after the drawings themselves were finished, during later phases of design or construction. (figure 6, figure 7)

All Saints Church in Brockhampton was designed and built in 1901-02. It was William Lethaby's last building.

Like many other Arts and Crafts architects Lethaby believed that the way for architects to become real builders as in the past was to assume, where possible, the responsibilities of both, building contractor and clerk of the works. (Robens 1986, 156)

This is why Brockhampton Church was built with direct labor and Lethaby's assistant acted as the clerk of the works. Constructing the building directly, without employment of a general contractor with whom the design would have had to be communicated, influenced the nature and character of the drawings produced for this church. The drawings kept developing and changing all the way through construction and they clearly became a tool for building. There is a great (much greater than in case of Ronchamp) continuity between drawings and the process of building which was very much in the spirit of the Arts and Crafts period and in the spirit of Lethaby's beliefs.

Lethaby was acutely aware of the growing divide between thinking and doing, designing and making and he sought all his life to bring together design and the experience of craft, and to allow workmen some dignity and responsibility in their tasks. This meant that everything should not be tied up in advance in drawings, instead there should be room for negotiation, development, experiment. The building should be allowed to evolve in response to the caresses of many creative hands. (Blundell-Jones 1990, 30)

In addition to all the notes and changes that are marked on the drawings, there are actual and quite substantial differences between drawings and the building as it was constructed. For example bay dimensions and dimensions of the windows are adjusted in relation to the drawings, even though

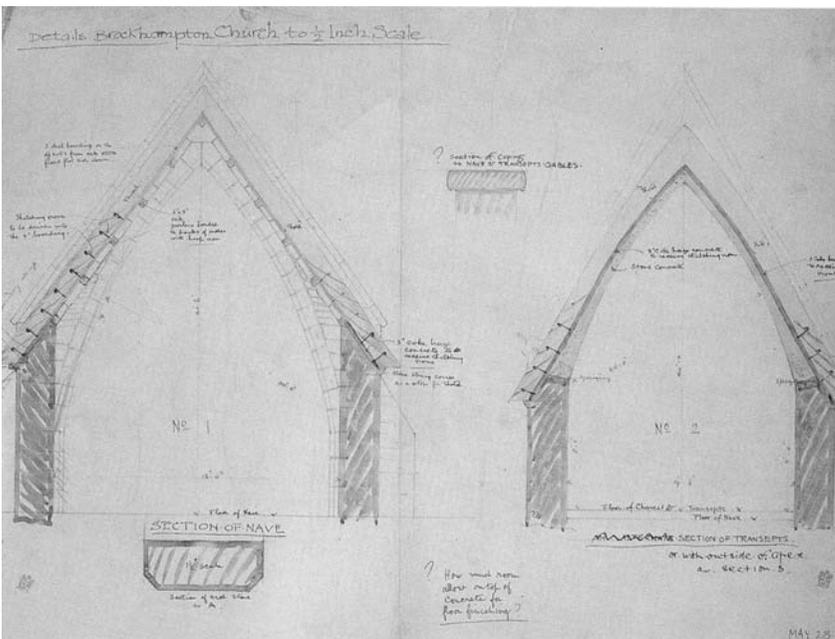
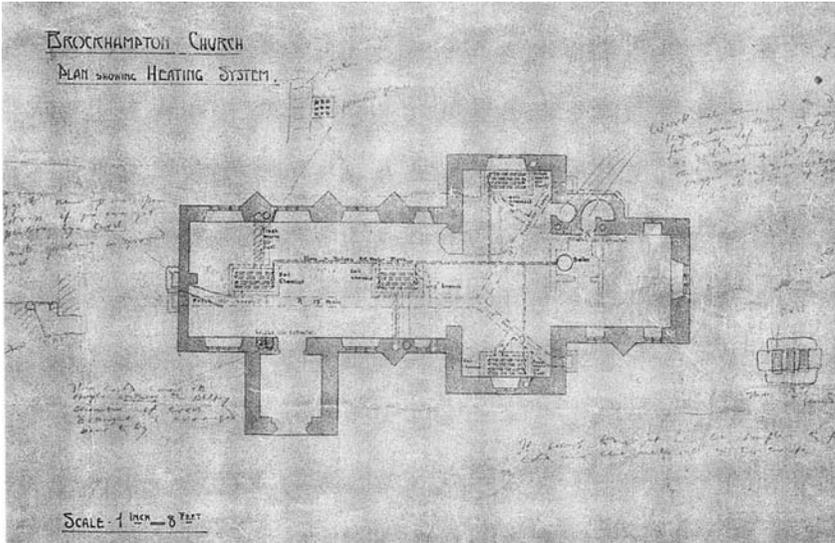


Figure 6 and 7: Plan and detail sections of All Saints Church in Brockhampton (RIBA archive, London)

they do not conform to any prescribed proportioning system, but adjusted during the construction phase based on what looked right. (Blundell-Jones 1990)

These “discrepancies” are a testimony to the building “growing” from and beyond the drawings rather than being fully defined and set by the drawings.

The drawings and the building are a continuation of each other. There is no distinction or clear moment when the drawings end and the building starts. In this case the words of Robin Evans that architects make drawings of buildings and not buildings do not hold. In this case the drawings are as present as the building.

3. CONCLUSION: EFFECTIVENESS OF THE METHOD AND FUTURE POSSIBILITIES

These two preliminary case studies will be treated as experiments that will now give me basis for thorough development of a methodology that will be employed in the overarching project. At this point they reveal the following difficulties:

- The inadequacy of the archives which in one case was extremely large and somewhat difficult to sort through as well as the direct access to the actual drawings was denied and the other one allowed direct access to drawings but the its holding was relatively incomplete.
- Importance of not only examining drawings but also acquiring information on the role of the architect himself or herself and other members of the office in preparing specific drawings
- Importance of acquiring information on the specific relationship between the contractor or builder and the architect

On the other hand these preliminary case studies do show promise of the eventual success of this project as they reveal that by methodological examination of drawings one can reconstruct not only the design process employed for a specific building but also the belief system of the architect, what his or her conviction on what the essence of architecture is and how they understand the relationships among the building, the outside world, the visitor, the architect and the builder.

In the case of more recent buildings it is very probable that the records available will be complete, however seeing and touching original drawings may not be relevant in case of buildings that have been designed exclusively with digital media. In such case I will visit the architect’s office in order to familiarize myself with his or her methods of working and tools that they are using. Understanding of these tools will be very important in understanding and analyzing the nature of the relationship between the representation and the constructed building. Another reason for an office visit and an interview with the architect will be to understand thoroughly the nature of the relationship between the architect, the office and the contractor, where this relationship has been changing significantly in the modern practice.

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Bakhtinian dialogism as framework for participant architectural research

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ABSTRACT:

This paper examines a framework for participant architectural research inspired by Bakhtinian dialogism. It does so by testing this approach on a current study of the recently completed Barking Town Square in Barking, England, in the context of urban regeneration in a London suburb struggling with issues of identity. A dialogic framework is derived from two principles of dialogism: entities are described by relations of parts rather than homogeneous wholes; and identities constantly change with respect to the uniqueness of a situation. For the architectural project, this means that participants and objects are defined by their relation with others in the project and that their identity changes over time as these relations evolve. It also means understanding architecture as a complex social process rather than a “thing in itself”. Finally, the approach assumes the presence of an embodied subject and identifies the researcher as a participant in the architectural process. Participant architectural research therefore implies that research consciously engages in the continuing and dialogic process of giving meaning to a place. Empirical data has been collected using socio-anthropological fieldwork methods of interviewing and participant-observation for the last year and a half. This approach, more attuned to the analysis of social and cultural relations and the “Other”, complements the necessary engagement implied by a dialogic framework.

CONFERENCE THEME: Approaches (alternative approaches in research methods)

KEYWORDS: Architecture, Methodology, Dialogism, Participation, Barking (London, England)

INTRODUCTION

The word “participant”¹ in “participant architectural research” implies that research, either through design or criticism, plays an active role in the process of giving meaning to a place. This role is active because research engages knowingly with the mechanism of place-making. What this paper suggests is that this engagement is dialogical and it does so by exploring a framework for participant architectural research based on Bakhtinian dialogism. To engage dialogically means to recognize that entities are primarily defined by their relations to others. This leads to a threefold way of studying architecture based on the notions of alterity, heterogeneity and participation. This approach is further supported by methods in social anthropology more attuned to the analysis of social and cultural relations and the “Other”. A dialogic framework thus defines an alternative methodology for architectural research giving emphasis to both material and social relations over formal analysis. This methodology, although it may be useful in framing or re-framing any architectural project, is particularly suitable when a project is claimed to address public engagement issues. Therefore, this paper draws on an extensive case study of the Barking Town Square in Barking, England, a project with relative participatory claims and one that I have been studying intensely for the last year and a half through interviews, fieldwork and participant-observation. Following a brief introduction to the Town Square project I will define the dialogic framework and then give examples of its use in three sections corresponding to the notions of alterity, heterogeneous identity and participation.

BARKING TOWN SQUARE

The Barking Town Square is a public space project recently completed in the London Borough of Barking and Dagenham (LBBD). (see Figure 1) It was designed by MUF architecture/art as the public realm part of a developer-led mixed-use regeneration project called Barking Central designed by AHMM Architects. Although it has recently been handed-off to the local authority, the overall

project has taken over ten years to come to this point. In 1999, the LBBD organized an architectural competition to officially launch the project which had been on the drawing board since the late 1980s as part of their Town Centre regeneration strategy. A separate competition was held in 2004 for the public realm part which was designed and built in three phases from 2004 to 2010. In announcements ten years apart, and regardless of changes over the years, local authorities were proud to state that the new Town Square was a “new heart for Barking”.



Figure 1: Plan of the Barking Town Square (left) with its location in the Town Centre. New buildings are in grey.

Barking occupies an interesting place in the national and local cultural geographies. Located in the east of Greater London in the area called the Thames Gateway, Barking is a former industrial area that has been dramatically affected by the decline of the manufacturing sector in England and has regularly been referred to as one of the country’s most deprived areas. There have been regeneration efforts in the centre of Barking for the last thirty years which now seem to bear fruit with “London’s move eastward”. Indeed, at one point in the project four different governmental bodies from the local, London and national levels had some claim in the Town Square development, confirming the larger planning trends affecting the area. With respect to its identity, Barking is a problematic place. Its identity sits between a relatively prosperous old town of the 1920s and a generic and depressed suburban centre, between London and its surrounding counties, between the old left and far-right politics. Demographically, it is representative of larger socio-economic and immigration trends in England. This conflicting identity seems to have been exacerbated by the recent developments which makes the identity of the Town Square problematic in itself. Most designers and developers I spoke to, including the partners at MUF, agreed that the identity of the town had to somehow be reinvented. Others admitted that the town did have an identity, but that it was a “battered identity” and “not one you would wish to draw from.” The local authorities in Barking acknowledge that in essence, the regeneration of the Town Centre, and especially the Town Square development, was meant to change the socio-economic nature of the town bringing in new residents on higher income. With so many actors reinventing the “heart of Barking” over a period of ten years it should not be surprising that the Town Square project appears laden with the multiple conflicts of regeneration.

The project for the Town Square did not involve direct design participation. But it had, through initiatives generated by the borough and MUF, a series of community art projects that gave the project a relative claim to public engagement. These projects aimed at somewhat alleviating the tension that may arise from lengthy regeneration projects between an existing community, local authorities, private investors, designers and new residents. As modes of engagement with the local population, we have to locate these activities somewhere between the legal requirements of consultation and the strategies of participatory design. They were neither simple questionnaire nor shared authorship,

but an alternative means of finding a place for architecture and local residents in the complex and continually evolving process of place-making. When describing these projects, both partners at MUF talk about allowing local residents to create their own narrative structures for the place over time. In other words, they see the projects as part of a longer series of similar events rather than singular occurrences. Although the involvement of the designers has ceased since the handover, the borough continues to link community engagement with the Town Square by investing in the place through its arts program. In parallel, there has been stable interest in the project from the design and education sectors, of which my current research is one example. The changing relations between participants, the duration of the project, the problematic identity of the place, the claim to public engagement by the designers and being able to participate, as a researcher, in a current process of place-making make the Barking Town Square a particularly relevant case study for a dialogic framework.

DIALOGIC FRAMEWORK

Bakhtinian dialogism describes the complex and inter-subjective relations at play in any social situation. A dialogic framework is therefore useful to conceptualize the relations between individuals engaged in a creative process and the interaction of research as part of that process. Given its emphasis on aesthetic and ethical relations, dialogism is relevant as a research and design framework in architecture. However, if we compare its use to other literary criticism and cultural theories, such as the work of Barthes or Benjamin, dialogism is relatively absent from architectural theory and criticism.² The present research uses dialogism as a framework for architectural design and research and thus extends the use of Bakhtin's ideas to new territory. This is not dissimilar to Haynes' use of Bakhtinian concepts. In her critique of the visual arts, she claims to be entering into a dialogue with Bakhtin's ideas, putting them into new situations, and states "I take his discourse not as authoritative, but as internally persuasive, as inviting development, extension, and application toward the goal of creative understanding." (1995, 15) It must be noted, though, that one of the reasons behind the lack of architectural scholarship employing Bakhtin is that his texts do not explicitly address material or spatial concerns so these have to be inferred or "materialized". (see Brandist and Tikhanov 2000; Côté 2000; and Gardiner 2000) For the present study two fundamental aspects of dialogism are employed: entities are described by relations of parts rather than homogeneous wholes; and identities constantly change with respect to the uniqueness of a situation.

Because dialogism conceives of people and objects as a set of relations changing over space and time, it may be put forward that dialogism would describe architecture similarly. In other words, a dialogic conception of architecture is akin to the one derived from Lefebvre which understands architecture as a process over time and space rather than as a "thing in itself". (see Lefebvre 1991, 90; and Borden 2001, 6-9) For Lefebvre, the reduction of social processes into specialized categories means treating something as a spectacle rather than "uncovering its latent social relationships." (Lefebvre 1991, 90) Bakhtin warns us of the same, although for him such rigid categorization is framed as covering the "brute heteroglossia of the real world and crude real life." (Bakhtin 1981, 386) Instead of seeing these categories as fixed, "Bakhtin problematizes such demarcations, sees them as fluid, permeable and always contested" (Gardiner 2004, 30) and thus allows for the heterogeneity of society with all contradictions, agreements and disagreements to be accounted for. So if we take the development and use of the architectural project as a social process with cultural, economic and political ramifications then the "social theory" derived from dialogism becomes especially pertinent to contemporary architectural research. (see for example Crossley and Roberts 2004; Gardiner 2004; Hirschkop 1999; Hirschkop 2004; Morson and Emerson 1990; Roberts 2008) What this theory suggests is a framework opposite to any idealized conception of society. It also takes everyday life as its foundation and thus emphasizes the importance of the embodied subject (or user) rather than its idealized version. (Gardiner 2004) The object of design, in this case, becomes both a result and a structuring element of the complex dialogic relations between client, user, designer, builder and researcher.

In terms of methodology within architectural research, dialogism is best approached through cross-disciplinary methods drawing on social anthropology. In this research project, participant-observation, interviews and fieldwork have played major roles. The emphasis of these methods on the

reality and presence of the researcher is essential to architectural research in which the researcher's role is acknowledged as a participant in the project. For the last year and a half I have been studying the Barking Town Square using this approach, interviewing designers, other participants and residents. As is argued by Proctor (2006), the principal goal of this approach is not only to gather information but to understand how the different participants conceive of the project and ultimately conceive of others in relation to the project. I have also lived in Barking, observing, participating in local events, establishing a network of contacts and organizing workshops on public space. My presence is therefore not disinterested and I am consciously engaging in the process of place-making that is currently happening in Barking.

ALTERITY

The founding principle of dialogism is that it is impossible to conceive of any entity outside of the relations that link it to the other. (Todorov 1984, 94) This suggests that an entity (a person, an organization, a project) can only be understood when taking into account the influence it has on others and the influence others have on it. It also suggests that larger wholes made up of such entities are not homogeneous, but complex heterogeneities. This tentatively links Bakhtinian dialogism with assemblage theory in which wholes at varying scales are characterized primarily by relations of exteriority. (DeLanda 2006) It also allows us to avoid micro- and macro-reductionism so that an entity at any scale can be said to have “objective existence”. (40) This link may seem tentative at first, but it is quite useful in defining a framework which takes into account all participants in a project, from individual persons to individual organizations, and the effect they have on each other.³

Let us take the firm MUF as example. Understanding the Town Square project through a dialogic framework means conceiving of the designers as an assemblage of external relations. So instead of being independent, MUF becomes a network of relations between themselves and the LBBDD, other architects, the developer, sub-consultants, local residents, etc. (see Figure 2) This situates the participant in the social reality of the project. In this case, a firm made up individual persons becomes

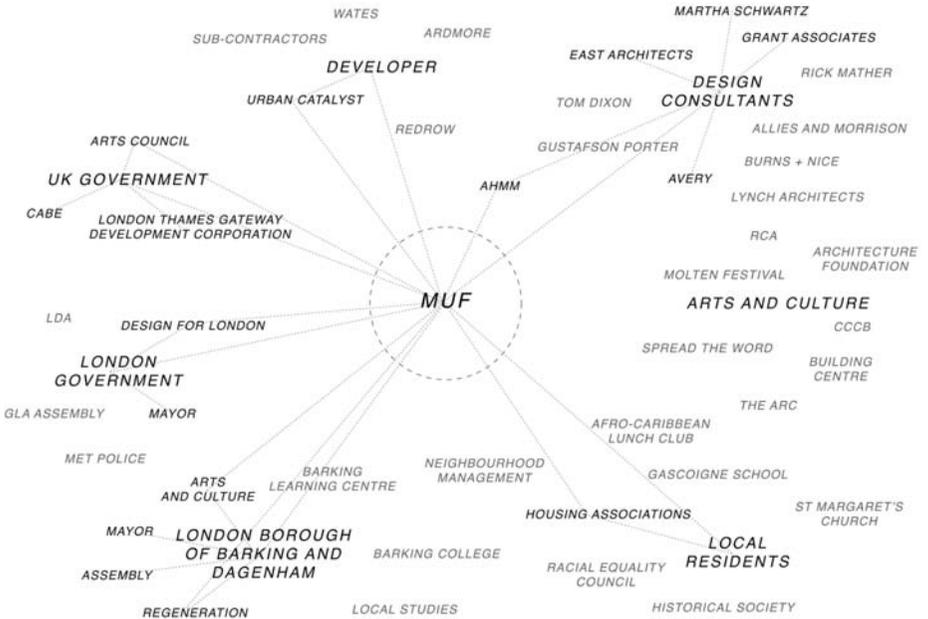


Figure 2: The design firm MUF as an assemblage of external relations with other organisations. The dashed lines indicate a specific instance of this assemblage in time showing relations circa December 2004 when MUF was appointed to the project.

its own entity. At a certain scale, as De Landa explains, it is appropriate to think of MUF as an individual participant regardless of its internal relational structure. Whether a design decision was taken by partners Liza Fior and Katherine Clarke or others in the office is only relevant depending on context and scale. What is important is that we understand decisions as part of an assemblage of relations. This reaches to the beginning of MUF's involvement in the project with their appointment. The important aspect of the decision in terms of alterity, according to informants, was that MUF presented an alternative to the safer and perhaps more developer-friendly Martha Schwartz, another competing firm. So from the start, their place in the project is defined by a relation to an other. This follows into design development and MUF's collaboration with the building architects in the project. Informants from both firms concurred that at times decisions were made separately and other times conjointly but always in relation to each other's work. With the borough, the designers developed what was described to me as a "special relationship", one that was "like family". Liza Fior insisted on this, stressing that although MUF was employed by the developer, they acted on the knowledge that the Square would eventually be handed over to the borough and so kept in close contact with key participants at the LBBB. With the local residents the relationship is more complex. Public engagement was limited to peripheral activities not included in the main contract and only with specific groups. Although this exposure meant for the architects that they were exposed to "a different set of demands" it also meant that the majority of local residents were not exposed to the work of the office. Indeed, both AHMM and MUF are routinely confounded by local residents into a single "architect" responsible for both buildings and open space. However specific or general the engagement may be, what matters in this study is that both participants, MUF and local residents, are defined by their particular relationship.

Similarly, the Barking Town Square needs to be understood in relation to its context. Here again scale plays a defining role. Whereas the project itself is an assemblage of "other" places: an arboretum, a plaza, a stage, a folly, and an arcade, the project within Barking only makes sense in relation to other local public spaces. As it was described by an informant, "it's part of the Town Centre and it's making this whole place work." (see Figure 3) A 2003 urban framework anticipates this by representing the



Figure 3: The Town Square (in centre, broken down into individual elements) as an assemblage of relations with other places in the Barking Town Centre. The dashed lines indicate connections between the Town Square and the surrounding open spaces.

Town Centre as Debord's *plaques tournantes*. Within the Town Centre, the Town Square needs to be understood in relation with the existing fabric as well: a civic core within a small commercial centre surrounded by low density housing estates. This was the historic part of the town known as "Old Barking", but it is now mostly dominated by architecture of the last sixty years with few listed buildings. The new development has very little relation to the existing fabric and the "otherness" of the project reinforces the relation between old and new. If we move to the scale of the LBBB or London the relations change accordingly. Within the borough, Barking is continuously contrasted with neighboring Dagenham, a large suburban residential area. Most of my informants repeated the same thing: Barking is the focus of regeneration and a place with history while in Dagenham "there is nothing to give emphasis to." The relation of Barking within Greater London is defined by its incorporation into London in 1965. A local resident expressed this by saying that the most significant change she had witnessed in her lifetime was that Barking had "altered from a clearly defined town on the London/Essex border into part of the greater London overspill." So according to a dialogic framework, the Town Square needs to be understood as a series of relations at different scales rather than a "thing in itself". It would indeed be impossible to define the identity of the Town Square without putting it in relation to the Town Centre, to Dagenham and to Greater London.

IDENTITY AND HETEROGENEITY

The reliance on alterity in Bakhtin's thought leads to conceiving of identities as constantly evolving rather than fixed (Bakhtin, Holquist, and Liapunov 1993, vol. 1). The identity of an entity does not evolve independently, but according to its relation to others and the uniqueness of situations. An entity is therefore "unfinalizable", according to Bakhtin, because its parts can never be made into a fixed whole. But this does not mean that the identity of a participant or a project lacks any sense or definition. In both Bakhtin and De Landa we encounter elements that contribute to the definition of identity either by making it more homogeneous or heterogeneous. These are centripetal and centrifugal forces in Bakhtin (acting on heteroglossia), and territorializing and deterritorializing factors in De Landa (acting on assemblages). In the case of architecture, the identity of the project or any participant is affected according to the actions of individuals and their immediate context, through use or interpretation over time, and this is what makes the project ultimately "unfinalizable".

Let us start from the same departure point using MUF as an example. We have seen how within a dialogic framework the designers are defined by their relations to other participants in the project. These relations in turn are what constitute the designer's identity, which evolves over time and according to specific situations. In this case, the identity of MUF at the start of the project can be said to be somewhat homogeneous contextually. It is very much defined by the previous work of the office and the relation it already has with some of the participants, but it is yet to evolve according to the particular evolution of the project. For example, there was a change of developer in 2005 which meant that the designers had to adjust to a new situation. MUF designing in 2004, at the very start of the project and employed by the previous developer, is not MUF designing post-2006 and employed by the new developer. The change had a destabilizing effect on the designers' identity, so that it cannot be said to be homogeneous throughout the project. Liza Fior, for example, speaks of making specific design decisions in order to "gain trust" with their new client. On the other hand, a handful of key people from the LBBB followed the project throughout, which gave a sense of stability to an otherwise unstable process. MUF's relationship with the LBBB, therefore, could be said to have had a counter-balancing homogenizing tendency on their identity as a designer in Barking.

In a similar way, the identity of the Town Square has evolved over the years according to public representation, design intentions and management issues. Let us start with its representation to the public. Standard consultation happened in the early stages of the project but never on MUF's design for the Town Square whose principles (drawn first by Avery and then AHMM) had been accepted before 2004. The original competition entries for Barking Central were exhibited and voted on in 1999 but had little to do with what was eventually designed and built. This meant that when the final project was exhibited in 2007 and finally built it bore very little resemblance to what people originally saw and voted on in 1999. Yet at the same time it also meant that people who had not seen the original project wondered why this had been built without proper consultation evidenced

by the repeated comment “nobody asked me for *my* opinion” and the overall sense of disconnection between local residents and local authority. In a similar way, some design choices destabilize the project’s identity within Barking by deliberately importing references from Edwardian England, France and Italy. Furthermore, the folly wall, the subject of a separate commission to MUF by the LBBD Arts department, quite literally re-constructs a fictional historical artifact by the assemblage of architectural salvage material, none of which was sourced locally. For the designers, this is part of the re-invention of Barking’s contemporary “battered identity” through narrative. For some local residents the folly does act as a foil for the continuing regeneration process, but for others, these intentions are yet another sign of lost identity.

A good example of centripetal and centrifugal forces acting on identity came out of a recent workshop I organized on the use and management of the Square. In one conversation, representatives from the local authority agreed that the Town Square requires a strong identity, making it more homogeneous. “It needs its own brand and to be its own entity.” Another said “you need to establish that brand and have a program across the year so that people identify the square with events, activities, somewhere to get information. So that is its identity.” However, at the same time, they looked for ways of having it appropriated by a variety of publics doing different activities, thus making it more heterogeneous. “Initially the council as an entity should promote the space as an open space.” By marketing it that way, it was hoped that the a “flow of ideas” would come from the public taking more “ownership of the place”. Another example of these conflicting factors influencing identity is found in the design intentions for the Square. On the one hand, the partners at MUF describe the design of the space in terms of “open-ended design”, “ambiguous detailing” and “making space for more than one thing at a time”. For example, the area of the Square is divided into four distinct zones each with its own label and aesthetic identity, which has led certain critics to describe the project as collage, in other words something without a fixed meaning. But on the other hand, the partners also acknowledge that the design is quite prescriptive in its physicality. Its nature as a constructed artifact makes it relatively resistant to change. So while the place is designed to allow for a variety of uses it also prescribes what these uses could be.

Because we are taking architecture as a process rather than as an object, it makes sense that Bakhtin’s principle of unfinalizability applies to this study. That is to say, the architectural project is not finalized when construction is complete. The workshop mentioned above is one example of how participants in the project are acting on the evolving identity of the Square and re-inventing its meaning through management and use. Another example is how, after the involvement of the architects has ended, the council has continued investing in the place through its Arts and Regeneration departments, using it as an official venue for events. We may think that for the designers the project is finalized once it has been handed over to the client. It is only in a very narrow sense. In an interview with individuals at MUF, it was clear that there was a sense that the project was indeed completed. As mentioned above, the “prescriptive” physical aspects of the project were enough to give it that sense. As were the immediate concerns of management and care. But it is quite the opposite for their representation of the project which has evolved over the last few years in lectures and interviews with some aspects being left out and others added.

The conception of entities based on external relations means to understand identity as the result of a constantly evolving dialogue. The important point for a dialogic framework is that this is true for the identity of both the project and its participants. Furthermore, conflicting aspects of identity, like the centripetal and centrifugal forces mentioned above, are not problematic or illogical but inherent aspects of heterogeneities. Contradictions like “open-ended” and “prescriptive” can naturally co-exist.

PARTICIPANT RESEARCH

The concept of participation is a rather tricky one to derive from Bakhtinian dialogism. Because the bulk of Bakhtin’s work is literary criticism, the notion of participation has to be abstracted from the aesthetic and ethical relations between author, character and reader, as mediated through a work of art. (see Hirschkop 2004, 61) In our case, these relations are mediated through a work of architecture. The critique of the author found in post-structuralism or reception theory, for example, is also found in Bakhtin’s critique of authorship. The reader plays an active role in defining the

meaning of a particular work that is partially independent of the author. Switch reader for user or interpreter and the corresponding critique in architecture can be described through dialogism. Participation, in this sense, is a wide-reaching notion because it may mean different but related activities. A participant may well be engaged in design, construction, and/or interpretation and still be participating in the process of place-making. The important principle is that their participation influences the overall definition of the place by creating another set of relations of alterity and by either affirming or transforming the identity of the place. Furthermore, and as is the case in social-anthropological fieldwork, the participant researcher must be conscious of their own effect on the process investigated and make this part of their research.

There are two significant ways in which my own actions as a researcher influence the process of place-making in Barking. The first is the influence I have on other participants, on their identity and their understanding of the project. Architecture and design are not easy things to discuss, and this dramatically influences the interview process. When we take architecture as a social process, it only makes matters more complex. More often than once, I sat down with a local resident to have a chat about the Town Square when they had never discussed the matter before. On these occasions, I would often answer questions about the details of the project, realizing that in the end, I had directly affected the informant's understanding of the project. The same is true of my relationship with the designers. Because we have had several interviews, ideas have had time to cross over. While the first interview I had with Liza Fior was much about her talking through some facts about the project, the last two have been closer to a dialogue during which we discuss and exchange ideas. For example, a question about defining the word "public" prompts her to write down her answer for future use. On another occasion, some photographs I took find their way into her representation of the project. With respect to the council, I have recently organized a workshop on the use and management of the Town Square, deliberately interacting in the process because it felt important that there be a dialogue on the matter.

The second way is the reverse of the first, or how other participants affect my understanding of the project. One of the reasons why social-anthropological methods are relevant in this case is that the project does not have the advantage of a fixed archive as a historical project would have. Research started while design and construction were still under way so most documents are still unaccounted for. This means that my understanding of the project evolved alongside its own evolution, supported more by a network of informants, on site observations and participation in events than existing literature. Some informants have had more impact than others, especially when they want to meet several times, are quite liberal about their opinions, or introduce me to their friends and colleagues I "have to speak to". Sometimes I would catch myself talking through one particular aspect of the project, framing the answer according to the person in front of me. In the end, my understanding of Barking and the Town Square is very much based on the network of relations I will have established during research. What is important, in this case, is to monitor how the researcher's understanding moves from prejudices to informed opinions. It is also about carefully framing each research event in the uniqueness of its situation: who is involved, where does it take place, does it relate to other events, etc.

CONCLUSION

To summarize, a dialogic framework for architectural research is based on three notions: alterity, heterogeneous identity, and participation. There are three main reasons that stand out in the analysis as to why a dialogic framework is relevant. The first is that such an approach describes architecture as an intricate social process over time rather than a "thing in itself". The second is that by focusing on relations, such a framework bridges the gap between material and social concerns in architecture. And finally, the approach assumes the presence of an embodied subject and therefore identifies the researcher as a participant in the architectural process. It would follow that any architectural project could be studied through a dialogic framework as an evolving series of relations. But what would be perhaps more interesting would be its use to study practices and theories claiming an element of participation or public engagement; what place-making, community architecture, participatory design, open-ended design, creative use (Hill 1998), and relational architecture (Petcou and Petrescu

2007) all have in common is that they address a **relational problem** first and foremost. In this sense, architecture benefits from being understood dialogically because the main participants in a project (client, designer, builder, user) are realistically situated in the “crude reality” of a socio-economic and political process that resembles a dialogue rather than a linear successions of events.

A further point of reflection can be addressed as a conclusion. It is evident that time plays a major role in a dialogic understanding of architecture. Not only because architecture is viewed as a process, but because long term engagement is necessary for architectural research and design to have any lasting effect on the process of giving meaning to a place. While the principal design firm was involved in Barking for a relatively brief period of time, it nevertheless had the benefit of working on separate commissions for public art projects that were part of the council’s scheme for community engagement. This investment of the LBBDD into the Town Square as a public engagement venue continues to this day, and so the designers were involved in a process that purposely goes beyond the time limitation of their contract. In addition, the scheduling of the project (perhaps unwittingly by the developers) into three phases over five years allowed for a dialogue to take place between the developer, council and the design firm that was not only mediated by drawn representations, but by actual physical construction. The physical form of the Town Square is thus allowed to somewhat transform over time according to a continuously changing set of constraints and possibilities. Also, the involvement of participants who followed the project through, a public design consultation body like Design for London for example, or particular members of the LBBDD council, ensured continuity in the project that would have been otherwise hard to achieve solely through the private sector. Finally, architectural research can support this continued process by engaging with it rather than remain a passive observer. For example, organizing workshops with participants who otherwise would not have time to do so benefits research, the project and ultimately the place in question.

ACKNOWLEDGEMENTS

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ENDNOTES

¹Throughout this paper, and unless otherwise specified, I will use the word “participant” to mean an individual person or group who officially participates in the project through design, funding, management, etc., as well as an individual person or group who participates either through use or criticism. In other words, a participant is anybody who is engaged in the process of place-making in Barking.

²This is not strictly speaking the case for all of Bakhtin's concepts. Jean La Marche's (2005) mediated construction project explores the relationship between architecture, dialogism and surrealism. Rob Shields' (1991) writing on Brighton uses the carnivalesque to explore social behaviour in public spaces. Hays (1996) briefly touches on the chronotope in studying Heyduk's work. And in geography, Holloway and Kneale (2000) have developed a conception of dialogic space by tracing the incremental scale of Bakhtin's concepts.

³Although I am aware of the many dangers of linking dialogism and assemblage theory (for example Bakhtin and De Landa's fundamental disagreement on the linguistic basis of experience), the goal of this paper is not to resolve these differences or have them co-exist, but to develop a framework that goes beyond their initial pairing. There is a tendency in Bakhtin's concepts to reduce an entity to its smallest fundamental parts. This is helpful at times, but may seem like overkill otherwise. De Landa's theory is helpful in adjusting this imbalance.

Energy performance of an adaptive façade system

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ABSTRACT:

The objective of this study was to determine the influence of an adaptive façade system on the energy performance of a hypothetical office building located in a cold climate. The design of a nine-story office building was selected from an advanced design studio taught by the authors, and used as a case study to carry out a whole building energy simulation. The energy simulation was run by a state-of-the-art simulation tool, DesignBuilder, using EnergyPlus weather data in Minneapolis, MN and Houston, TX. An adaptive façade system was developed, consisting of a typical curtainwall system and an operable shading system. The energy performance of the adaptive façade system was numerically verified using Lawrence Berkeley National Laboratory (LBNL) software, and was used as input variables in DesignBuilder. The results of the analysis revealed the adaptive façade system consumes less heating energy compared to its static façade counterpart. The study addresses the importance of adaptive façade systems that contribute to aesthetics, technical innovation and building sustainability.

CONFERENCE THEME: Applied research

KEYWORDS: Adaptive façade system, energy performance, building energy simulation

INTRODUCTION

Buildings worldwide, more than rapid transit and other urban infrastructure are responsible for about 40% of CO₂ emissions, the US being the largest culprit by far (DOE 2010). CO₂ emissions in the US in 2008 were 14% higher than they were in 1990. In effect, a reduction in building energy consumption is a design imperative. As construction expands in countries such as China and India, absolute emissions figures are on the rise. Innovative design strategies to reduce energy consumption are essential in tackling future climate change and energy use.

It is well understood that climate is fundamental and highly effective in implementing sustainable building design by manipulating building mass and plan layout as a first step to reduce the use of natural resources and energy consumption. Building design must account for different urban settings and different climate conditions.

Achieving an energy efficient building is a complex process, influenced by various factors such as building envelope performance, occupant behaviours, operational schedules, HVAC efficiency, and environmental building performance, to name a few. The primary problem of the contemporary building envelope is its “static” nature in relation to its “dynamic” environment. Such a condition is not optimal for building energy conservation. Further, the energy performance of glazing systems is increasingly more important as contemporary buildings pursue higher window-to-wall ratios. In addition, energy performance is directly affected by heat transmission (U-factor), solar heat gain coefficient (SHGC), visible light transmittance (VLT) as well as air infiltration through quality workmanship. Therefore, in order to maximize energy efficiency, more in-depth research on high performance façade systems should be developed and applied in different climate zones.

This paper investigates how effectively and sensitively an adaptive building facade system affects the energy performance of an office building compared to a static façade system and which climate has greater environmental benefits from an adaptive façade system. The analysis of an adaptive façade system is applied to a studio project taught by the authors and demonstrates the benefits and challenges of an adaptive façade system. The study has developed the concept of using a shading system to create an adaptive façade to improve the energy performance of a building. An external shading device has been widely implemented across the building to address both of architectural and functional issues.

As an initial approach toward an adaptive façade system, an operative shading system was developed and its energy performance was numerically investigated. Two climate zones were considered in accordance with the ASRHAE climate zone definition: 1. Cold and humid (climate zone 6A) and 2. Hot and humid (climate zone 2A). Figure 1 highlights two cities used in this paper.

The primary objective of this paper is to conduct a comparative study of energy consumption of a building façade that utilizes an adaptive façade system in accordance with seasonal changes. A hypothetical 9-story office building located in Minneapolis, MN, and Houston, TX respectively served as the case study. The study focuses on demonstrating the energy efficiency of an adaptive façade system in two different climate zones compared to a static façade system. The study finally concludes with recommendations for developing a high-performance building envelope.

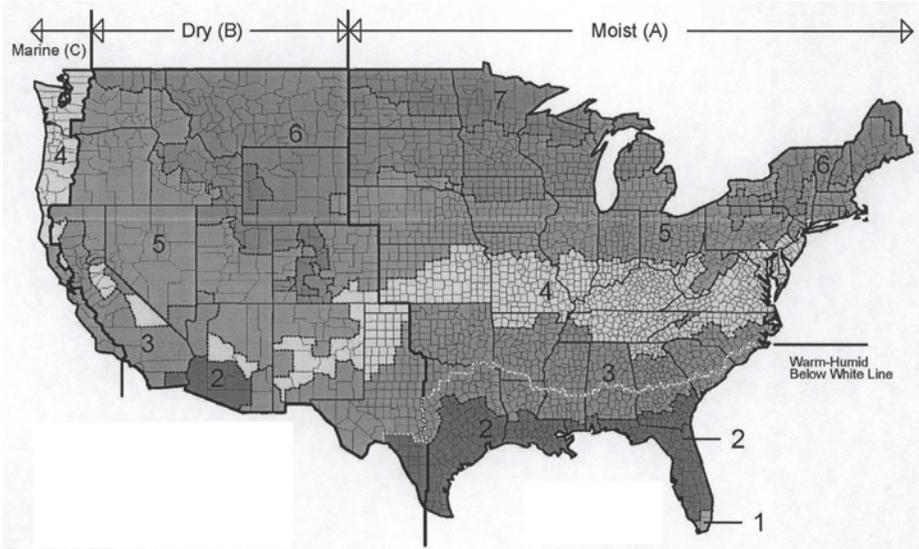


Figure 1: USA Climate zones and case study cities

I. MATERIAL AND METHOD

I.1 OUTLINE OF SIMULATIONS

The simulation of energy consumption of the case study building was performed using DesignBuilder, a whole building energy analysis software program that utilizes EnergyPlus simulation engine (DesignBuilder version 2.3). DesignBuilder is a building thermal performance simulation program performed on hourly-recorded weather data mainly consisting of sub-hourly weather data and illumination data. The simulation specifically focuses on calculating energy performance of a building façade system by changing its energy performance values while keeping other input parameters in DesignBuilder constant in each simulation run.

The nine-story office building study comprises a total of 14,000 m² gross floor area, which includes 12,000 m² for working spaces and 2,000 m² for service cores. The building mass incorporates outdoor spaces for recreational and green garden purposes. All internal spaces in the building were modelled as one thermal zone that maintains uniform indoor temperature and relative humidity.

The designed operation schedules were used as a typical office schedule set forth in DesignBuilder. The interior set point is 22 °C and 24 °C for winter and summer respectively with steady relative humidity of 30% across the year. The use of lighting and office appliances were also simulated with 24-hour schedules and a target lighting level of 50 lux. The opaque wall assembly made of batt insulation and spandrel glass set to provide an assembly U-factor of 0.363 W/m²-K. The roof and floors, constructed with metal deck and concrete, offers an effective U-factor of U-0.215 W/m²-K. These U-factors are also in accordance with ASHRAE 90-1 building envelope requirements. The

shading system is assumed to cover 50% of the entire building façade in addressing aesthetic and energy efficiency measures.

The simulation was carried out for two seasonal periods: 1. Summer mode from April 1 - when the cooling season starts - to September 30 when the cooling season ends; and 2. Winter mode from October 1 - when winter season starts - to March 31 when the heating season ends. The adaptive features of the building facade in summer and winter modes were simulated using simple performance values in DesignBuilder by changing its heat transmission (U-factor), solar heat gain coefficient (SHGC), and visible light transmittance (VLT). Figure 2 visualizes architectural characteristics of the case study building.

Table 1 summarizes the input parameters used in the DesignBuilder simulation. Input variables for the comparative study are highlighted in green in the table.

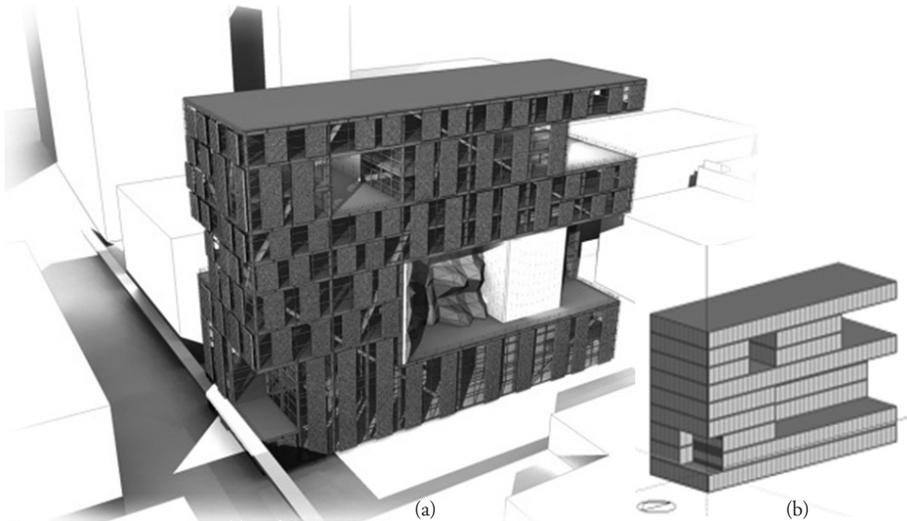


Figure 2: A rendered view (a) and DesignBuilder set-up (b) of a case study building

Category	Descriptions	Reference Values
Activity	A typical office working schedule and activities	Schedules set up in DesignBuilder
Environmental Control	Heating	22 °C
	Cooling	24 °C
	Lighting	500 lux
	Relative Humidity	30%
Construction	Roof and floor construction; cast concrete construction	U- 0.215
	Opaque wall lightweight construction; rigid insulation with spandrel glass	U-0.363

Table 1: Summary of input parameters in DesignBuilder

Fenestration	Window to wall ratio	70%	
	Double IGU with low-e coating on surface #2 + PV integrated laminated glass shading device	Baseline system	Adaptive system
		U-2.8 SHGC-0.2 VLT-0.34	U-1.9 SHGC-0.2 VLT-0.34
	Air exchange per hour	0.7ACH	

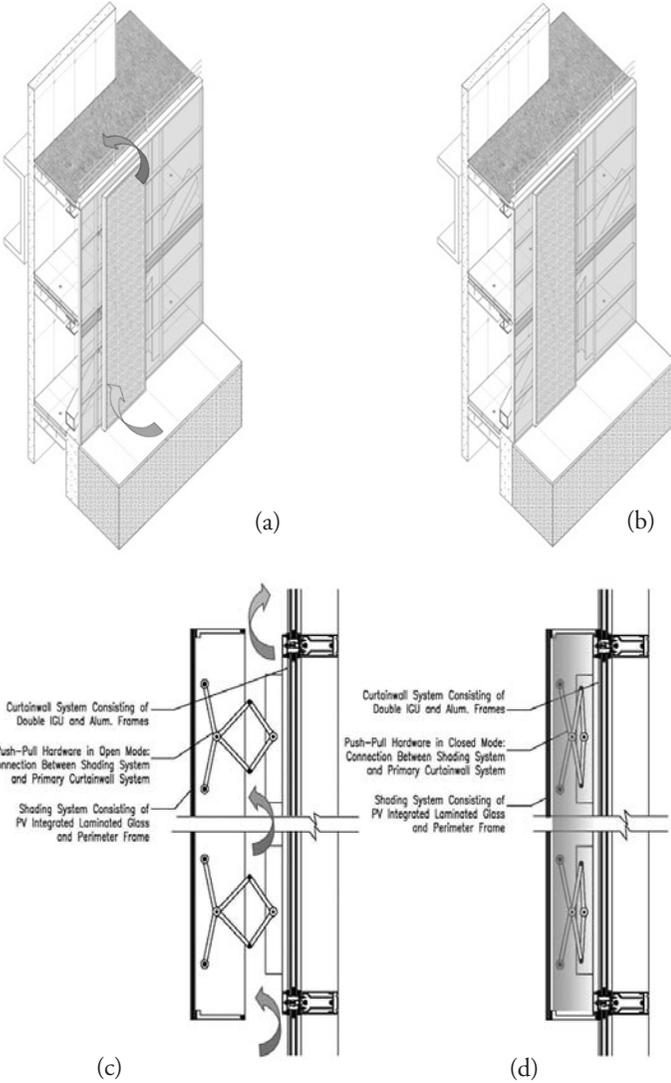


Figure 3: Axonometric views of an adaptive façade assembly in summer (a) and winter (b); sectional details in summer (c) and winter (d)

The fenestration system in this study consists of a typical curtainwall system with an integral external shading system. The curtainwall system consists of a low-e coated insulated glass unit (IGU) and thermally broken aluminium frames. The shading system is comprised of photovoltaic (PV) thin film laminated glass and an aluminium frame along the edges of a PV panel. The shading system is hung off from the curtainwall frames using operable brackets, providing a ventilated cavity in warmer seasons and a closed cavity in cooler seasons. For comparative purposes, a baseline façade system with an integral static shading system was also simulated in DesignBuilder. Sectional details of the adaptive façade system are illustrated in Figure 3.

1.2 CALCULATIONS OF ENERGY PERFORMANCE VALUES OF AN ADAPTIVE FAÇADE SYSTEM

The energy performance of a façade system is typically characterized by U-factor, SHGC, VLT, and air infiltration rate. The U-factor of an adaptive façade system was determined in accordance with NFRC 100 using Therm 5 (Therm version 5). Therm 5 is temperature-driven heat transfer 2D software that determines the heat transmission of a façade assembly, including material conductivity, radiation, and convective effects. SHGC and VLT of the adaptive façade system assembly were determined in accordance with NFRC 200 and NFRC 300 using Window 5 (Window version 5). The low-e coating simulated in this study is a spectrally selective soft coat that offers the best U-factor, SHGC and VLT available in current market. The PV laminated glass unit is simulated with metal-coated glass that offers similar SHGC and VLT to that of the thin PV film panel. The simulation here does not incorporate computational fluid dynamic (CFD) simulating thermal gains through solar radiation in the closed cavity during winter seasons. Figure 4 shows the overall heat transmission of an adaptive façade system resulting in the effective U-factor of 1.9 W/m²-K.

The effective energy performance values of the baseline and adaptive façade system used in both climate zones are summarized in Table 2. The calculation of these values took into consideration 50% of the façade area being covered with a shading system. It is observed that the major difference between the baseline and adaptive façade system is its U-factor and air exchange rate. The adaptive façade system results in an enhanced U-factor due to the insulative attributes of the closed cavity

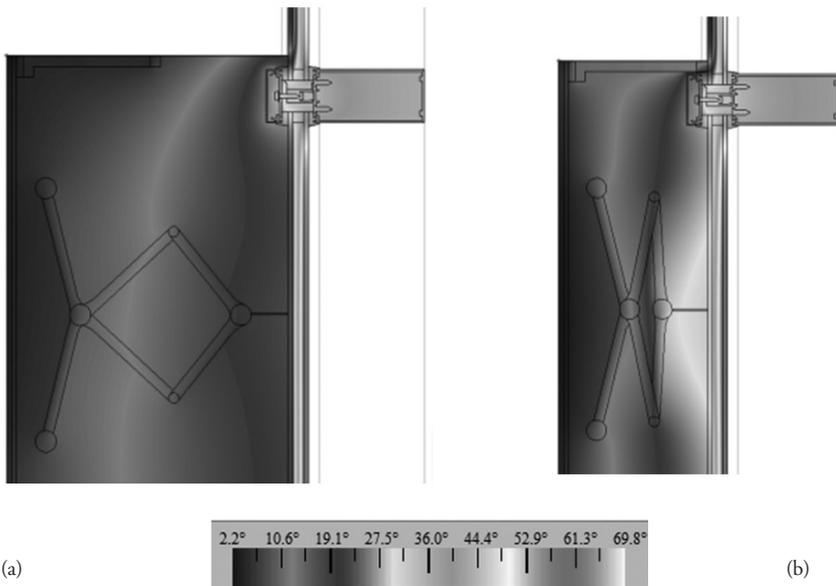


Figure 4: U-factor verification in accordance with NFRC100; façade assembly with ventilated cavity (a) closed cavity (b)

	Baseline façade system	Adaptive facade system
Effective U-factor	2.8 W/m ² -K	1.9 W/m ² -K
Effective SHGC	0.2	0.2
Effective VLT	0.34	0.34
Effective air infiltration rate	0.7ACH	0.5ACH

Table 2: Summary of energy performance of baseline and adaptive façade system

during winter months. The closed cavity also improves the air exchange rate, thus further contributing to energy conservation. In the absence of a simulation tool to estimate the air exchange rate, the air exchange rate of the adaptive system was assumed to be reduced by 30% compared to the baseline façade system, resulting in 0.5ACH. The values in Table 2 are the input variables in DesignBuilder for annual energy loss/gain calculations through the façade systems.

2. RESULTS AND DISCUSSION

The results of energy consumption of a 9-story office building located in Minneapolis, MN (cold/humid) and Houston, TX (hot/humid) are presented in this section. An annual energy simulation was carried out to assess the energy influence of an adaptive facade compared to a static façade system. The analysis revealed that the adaptive façade system consumes less energy than the static façade system. The same study showed that the adaptive façade system in cold climates offers greater energy saving than hot climates. Sensitivity analysis indicated that further energy saving can be achieved through strategically incorporating external louvers and fins into the adaptive façade system in both climates.

2.1 COMPARATIVE ANALYSIS RESULTS

The cooling and heating energy load of the building with the baseline façade system in Minneapolis MN was measured to be approximately 6,700MBtu (consisting of 2100MBtu/yr of the cooling load and 4600MBtu/yr of the heating load) whereas the building with the adaptive façade system in Minneapolis MN consumed 5,100MBtu/yr (consisting of 2300MBtu/yr of the cooling load and 2800MBtu/yr of the heating load). The adaptive façade system in Minneapolis provided approximately 1,800MBtu of energy reduction equating to \$20,000/yr operational cost saving compared to the baseline façade system. It was observed that both façade systems yields a similar cooling load consumption for summer months while the adaptive façade system consumes less heating load than the baseline system. This is due to the fact that U-factor and air exchange rates normally constitute a small percentage of the total heat gain of the building in summer seasons but they are major contributors for the heat loss during winter seasons. Figure 5 shows the monthly energy usage pattern and the energy consumption comparison between the baseline and adaptive façade systems.

For the hot climate where the cooling energy is dominant (Figure 5 (b)), the annual energy consumption of the baseline and adaptive façade system was measured to be 5700MBtu and 5100MBtu respectively. Although the heating energy is reduced by 50%, the total energy saving from this specific adaptive façade system is marginal because insulative facades are rarely beneficial and the solar control is more of a priority for such hot climates. Therefore, further research on the solar control attributes should be incorporated into the studied adaptive façade system focusing on geometry, dimension and materiality in relation to façade orientations and solar path. Figure 5 illustrates the comparison of the total heating energy between the baseline and adaptive façade system.

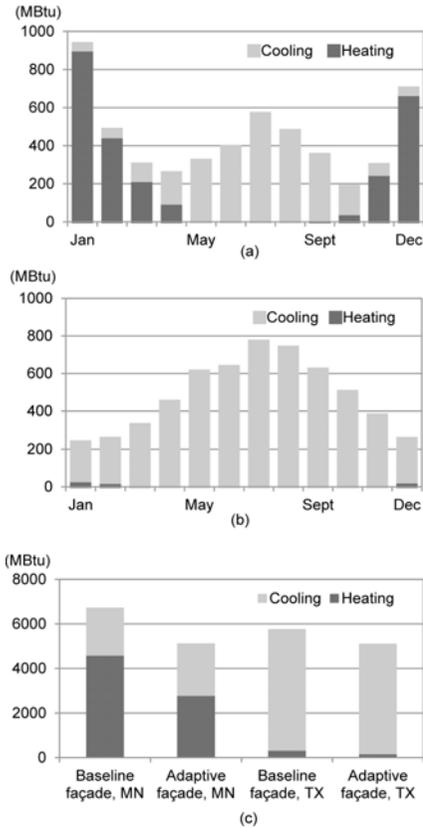


Figure 5: Monthly energy usage pattern in Minneapolis MN (a) and in Houston TX (b). Annual energy consumption comparison between baseline and adaptive façade systems in two climate zones (c)

CONCLUSION

This paper focuses on two objectives: first, to develop an understanding of how effectively and sensitively an adaptive building façade system affects the energy performance of a building compared to a static façade system and to analyse its energy performance in cold and hot climate zones.

The adaptive façade system consists of an exterior adjustable shading system installed adjacent to a curtainwall system, which produces an open cavity in the summer and a closed cavity in the winter to enhance energy performance.

A case study building located in a cold climate region was investigated and a whole building energy simulation was run. The result of the analysis revealed that the adaptive façade system substantially decreased heating loads compared to a baseline façade system. The adaptive façade system discussed in this paper works better in a cold climate than a hot climate zone, and therefore, additional study will be carried out to develop other adaptable façade systems that are suitable for hot and temperate climate regions. Further, the adaptive facade system will be experimentally tested to verify the simulated energy performance data against empirical data.

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Heritages' management and operative strategies on the Alto Douro Wine region, Portugal

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ABSTRACT:

The main objective of this work is to analyse the operative strategies of cultural landscapes such as policies, legislation/regulation, tourism, etc. The study subject is specifically, the landscapes that have strong rural and patrimonial characteristics. The main question is to assess if the used policies and initiatives are sustainable for the communities and local interests. Since 2001, the Alto Douro Wine Region has the UNESCO World Heritage status, and is thus regarded as a suitable case study that presents the opportunity to evaluate the pliability of the used strategies.

In order to answer to the goal stated previously, the used methodology has two main parts: i) a theoretical framework concerning cultural landscape narrative; ii) the analysis of the various documents and studies available related to the Alto Douro Wine Region, in the period between the pre-candidature until the present. It is a qualitative method based approach, providing the definition of guidelines that can be hereafter applicable on other cultural landscapes that are not classified by UNESCO.

CONFERENCE THEME: On Approaches: Ecology, sustainability, and changing societal and political economies

KEYWORDS: Cultural Landscape, Territorial Strategies, Sustainability, Alto Douro Wine Region.

INTRODUCTION

Over the years, the interest on *cultural landscapes* has increased amongst architects and urban or rural planners. Its significance has surpassed the disciplinary boundaries of cultural geography or landscape architecture. This fact can be explained by the social development and the inevitable territorial changes as a response to modern society demands.

The original view of landscape as a mere scenery by Cosgrove (AA.VV. 1988) has been replaced by the need to decode the various cultural signs, landmarks within landscapes, such as significant buildings. Therefore it is possible to view them as *texts*, more precisely – *hypertexts* (Ascher 2004) – narratives that can be read as a heterogenic whole and also as individual parts.

Various eras can survive in the same space and, consequently, cultural landscapes can be better understood firstly as space and secondly as a *mise en oeuvre* of time or as its immutable image (Marot 2006, 56-57). This immutability is somewhat paradoxical. How can landscape be viewed as a standstill frame of society? The collective memory, the traditional rites and the cultural identity are in fact the obvious answers thus unravelling why the cultural and patrimonial landscapes are relevant case studies. They represent an opportunity to showcase the past, the present and the future and, consequently, more versatile approaches: *le régional, le vernaculaire, les particularismes on cessé d'être passésistes; ils émergent à l'actuel et revendiquent l'avenir* (Berque 2000, 138).

In addition to the foregoing, the environmental and ethical issues also become relevant in this debate. The rural exodus, the desertification, the land abandonment, the destitution of identity by *globalization* (Singer 2004) and the *universalization* (Ricouer 2006) are some of the important aspects to be included in the design of territorial strategies. In the case of landscapes with strong patrimonial and rural characteristics, in order to be sustainable, they have to achieve an almost utopian equilibrium. Simultaneously, preserve and create the necessary tools in the territory for new dynamics and uses may occur, is crucial when one reflects on cultural landscapes.

This is somewhat conveyed by the reflexivity notion, that imply to think the territory in the past, present and future (Ascher 2004, 30). However, the adaptable reuse idea (Kincaid 2002) applied in

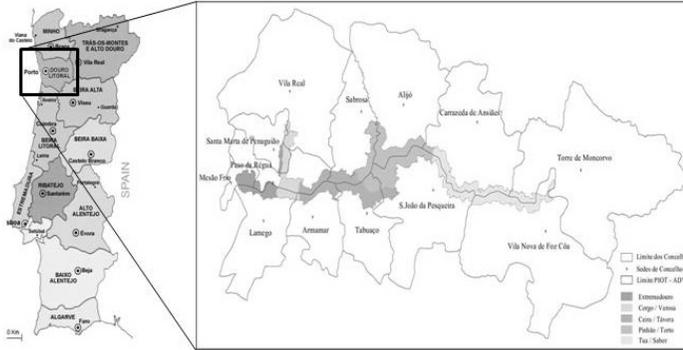


Figure 1: The Douro Region location and a zoom of RDD region with the defined area for the ADV region (PCM 2003).

buildings rehabilitation, is considered to have more explorative possibilities, which is nearer to this research purpose.

Analyse strategies that were designed specifically for cultural/patrimonial landscapes, such as the ones classified as World Heritages by UNESCO (1972), can be an important base for further considerations concerning the “active conservation” of cultural landscapes.

I. THE ALTO DOURO WINE REGION CONTEXT

The Alto Douro Wine Region (ADV – *Alto Douro Vinhateiro*) is an integrating part of the Douro Distinct Region (RDD – *Região Demarcada do Douro*), located on the north of Portugal (see Fig. 1). This landscape is composed by three major areas: *Baixo Corgo*, *Cima Corgo* and *Douro Superior*, and inevitably marked by the Douro River (see the zoom of Fig. 1). The cultural and wine based landscape, considered for UNESCO’s World Heritage category, has been built since the Marquis of Pombal¹ era, between 1757 and 1763. This fact alone makes it one of the oldest distinct regions in the world. Consequently, the collective memories and rites related to the wine production are inseparable aspects of this specific place.

In order to define the area most representative of the Alto Douro landscape character, the candidature to World Heritage was limited to the Alto Douro Wine Region.

However the remaining area of the RDD region was considered as a buffer zone of the ADV area. It was then stipulated that ADV region was considered an “experience” and its success would determine further experiments, extensible to the RDD region.

The ADV region is relatively homogeneous in its geomorphological and sociological dimensions. It was necessary to proceed to the specific surveys, mainly based on cartography, allowing to establish the various landscape characteristics: the soil use and respective maps, the biological diversity, the vernacular architectural elements (for example, the farms (*quintas*), where the owners of the wineries lived), the religious buildings and the different types of land use related to the wine production.

The composition of this specific landscape is obtained by three types of land use that still exist in an integrated way:

- Terraces built prior to the phylloxera crisis (see Fig. 2): Since 1863 and as a consequence of the phylloxera epidemic in the Douro Region, the old vineyards were continually abandoned or destroyed. This is translated in several extensions of land with dead vineyards – *mortórios* – which are still a part of the ADV landscape and layout. However, some of these old terraces

were rehabilitated for the re-plantation of vineyards and the old schist walls were preserved. These terraces still have an important role to play in the biological diversity of the landscape (Pereira 2001, 81).

- Terraces built after the phylloxera crisis (see Fig. 3): These terraces were built mostly in the end of the XIX century and in the mid 30's of the XX century, a direct consequence of the phylloxera plague that caused the European vineyard destruction. Therefore, the traditional grafting was substituted by the American grafting which was resilient to the insect. A new form of designing the vineyards was created. The landscape changed as well as the whole process of collecting the grapes; the application of zinc wire strings on schist walls replaced the *erguida* or *empa* (the vineyards were only sustained by the wood rods). The novelty was that the wood rods were attached on the strings as soon as the pruning season arrived (Pereira 2001, 84). The irrigation and drainage systems are also a part of the vernacular heritage in this particular landscape (Curado 2003, 256).
- *Patamares and Vinhas ao Alto*, a more recent form of terraces (see Figs. 4 and 5): In the 70's was developed the first model of patamar. It normally consists in two rows of wineries placed sideways to the contour lines and separated by a space of nearly two meters wide, where farm trucks can pass freely. However, this model is only recommended for 40% slope, and presents various problems when compared with the previous terraces. Its use increases the erosion risk, the growth of infesting plants, forcing more herbicide treatments (Pereira 2001, 85-86). In the last decades, more current models have been used, contributing to redesign the Alto Douro; however these are far from being the major process used in the various wineries territories. The fragmentation and the different kinds of social occupation of these territories, visible on the wine properties' dimensions and respective used techniques are important factors to understand the various types of the Alto Douro's wineries that invoke different eras and forms of territory occupation (Pereira 2001, 87).



Figure 2: Terraces before the phylloxera plague.



Figure 3: Terraces after the phylloxera plague in Valença do Douro. (Source: Miguel Flores, 2007).

These surveys reinforce the human effort and uniqueness of this particular landscape. The reaction to adverse morphological conditions and to the plague reveals the genius of a population and how this is connected to their collective identity.

The wineries (Quintas do Douro) – see Figs. 6 and 7 – are extremely important landmarks in the ADV landscape, as well as their buildings related to the wine activity.



Figure 4: Patamares in Tabuaço (source: Miguel Flores, 2006).



Figure 5: Patamares in Tabuaço (source: Miguel Flores, 2006). A new way of cultivating the vineyards, creating vertical lines, contributes to the ADV landscape layout.



Figure 6: The ADV region: an overall view. (source: Miguel Flores, 2008).



Figure 7: Quinta do Vesúvio Douro, one of the most impressive examples of quintas in the ADV landscape.

The religious buildings are not so expressive, scarcely placed on the territory, although the surrounding communities view them as significant landmarks.

All the data and the surveys anticipated a model of territorial management that would integrate all the different components that characterize the ADV landscape.

I.1.THE ADV REGION: TERRITORIAL AND PATRIMONIAL MANAGEMENT TOOLS

In the 80's, the Project for Rural and Integrated Development of Trás-os-Montes Region (PDRITM – *Projecto de Desenvolvimento Rural Integrado de Trás-os-Montes*) was developed and presented to answer to such problems as the handwork shortage, the decreased quality of wine trees, among others.

When Portugal became a member of the European Union, this region received important financial funds for its development projects, which contributed for the wineries modernization. However, the projects were focuses mainly economic factors such as the wine productivity. It was considered the risks to the region integrity but this was not the major factor.

The Intercity Plan of Territorial Organization (PIOT – *Plano Intermunicipal de Ordenamento do Território*) was designed with a different agenda; it is a tool approved by the Portuguese law – *Lei de Bases do Ordenamento do Território e Urbanismo* (AR 1998). In general terms, it was created to be an ensemble of guidelines (no-binding rules) to support an overall and integrated coordination – a common ground – in order to articulate the different and inter-dependent counties, despite their particular needs.

In the case of the Alto Douro Wine Region PIOT (PIOT-ADV) its primordial goal was and still is the preservation of the patrimonial landscape of the region. Considering the various interests and counties, were stipulated the following main objectives (Andresen & Curado, w.d.: 24):

- The definition of a global strategy for the protection and management of the cultural landscape that all the municipalities can participate;
- The articulation with other plans and programmes of local, regional and national interest;
- The analysis of all the intercity routes that structure the territory such as population density, infra-structures, transports and equipments;
- The analysis of all economic activities, particularly, social, environmental and economic dynamics.

The Plan was designed considering all the guidelines applied to the Municipal Plans (PDM – *Planos Directores Municipais*) and the dam reservoirs of Régua and Carrapatelo Organizational Plans (*Plano de Ordenamento das Albufeiras da Régua e Carrapatelo*). Related to the first mentioned plan it was analysed all the organizational charters, National Agricultural Reserve (RAN – *Reserva Agrícola Nacional*), National Ecological Reserve (REN – *Reserva Ecológica Nacional*) and their respective regulations, then allowing the territorial model design (see Fig. 8). This figure shows that agricultural activities (gray areas) occupy the major part of the territory, secondly, the natural spaces (white areas) and finally the urban settlements (black areas). The Douro River is represented by the line (see Fig. 8).

There are other no-binding tools concerning cultural landscapes management, similar to the existing Landscape Charters of Cataluña, Spain. They are supported by the existing vernacular architecture and heritage registers expressed by a “relevancy hierarchy” and environmental surveys among others, in order to catalyze a dynamic landscape (Preto 2009).

Simultaneously, it was created an Action Plan with regulating guidelines such as the promotion of the local heritage architecture and the ADV landscape as a whole, aiming its conservation. To implement these considerations and local PDM norms it was needed a regulating entity, designated as the Technical and Intercity Office (*Gabinete Técnico Intermunicipal*). However, this Office was of a

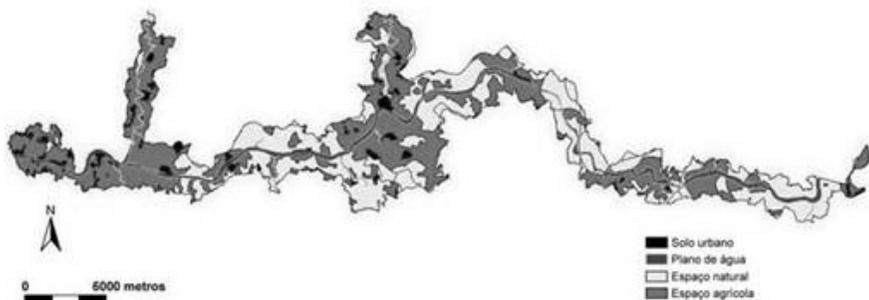


Figure 8: Territorial organization diagram (Andresen & Curado, w.d.).

short duration mainly due to the lack of funds. Between 2002 and 2005, the Office budget counted with the municipalities contribution with 25% funds and the Degraded Urban Areas Revitalization Program (PRAUD – Programa de Regeneração de Áreas Urbanas Degradadas) contributions with nearly 70% funds (AA.VV. 2001).

With the absence of this regulating entity, the PIOT-ADV struggled to survive to the different strategic points of view.

All municipalities joined efforts and demanded the clarifying situation, forcing the State to intervene and establish another entity with the same purposes as the referred above. Consequently, the Portuguese Minister Council has stipulated the following: the creation of the Mission Structure for RDD (*Estrutura de Missão para a Região Demarcada do Douro*) depending on the Environmental, Territorial Organization and Regional Development Ministry with the mission to reinforce and catalyse development actions in the Douro Region. It also has the responsibility to promote the articulation between the central and local entities of administration as well as stimulate the initiative and the participation of civil society (PCM 2006).

In this document they are also referred the competences of the responsible by this Mission (the President of Committee for Coordination and Development of North Region) in order to respond to the municipalities appeal, and it was nominated a representative for each of the intervenient entities.

The general plan includes the management of the various entities interests namely the Integrated Action of Territorial Base of Douro (AIBT-Douro – Acção Integrada de Base Territorial do Douro) and the LEADER+² program, reported and conducted by the Trás-os-Montes and Alto Douro University in 2003 (AA.VV. 2003b). The study refers the consequences and actions (legislation, creation of associations, etc.) concerning the ADV rural landscape.

The rehabilitation of the Salzedas Monastery benefited from the financing of AIBT-Douro and IPPAR, nowadays known as IGESPAR³. In several cases, it was verified that AIBT-Douro financed the second phase of rehabilitation works previously financed by the PRODOURO (a governmental program for regional development). Although, many historical centres were rehabilitated by its aid, this was not the original organization intent. The LEADER+ is referred as the one with the most potential to articulate the AIBT-Douro actions. However in some cases, it was verified the incompatibility of interests, almost competing ones, such as local products stores financing for instance, launched by LEADER+ and totally inadequate to the AIBT-Douro general agenda (AA.VV. 2001).

In fact the creation of partnerships must be viewed in the cooperation sense, conciliating the various factors concerning the landscapes management and the conservation of cultural assets. This is the reason why further and similar surveys should have been conducted and disseminated.

Actually and related to the wine production, an Iberian partnership between the Portuguese Office of Douro and Oporto Wine (IVDP – Instituto dos Vinhos do Douro e Porto), Trás-os-Montes University, etc. and Spanish entities (Technological and Agrarian Office of Castela and Leão and the University of Madrid) resulted in the *Suvidur* project. The project agenda is Douro's winery territories organization and the definition of non-obliging set of instructions allowing the agricultural activity maximisation. This experiment is currently taking place.

Theoretically, these initiatives contribute to the promotion of information and to data systematization, relevant when variety and numerous factors are in order. It is therefore a public service, the population is better informed and also an active way of management and knowledge.

The *Suvidur* project is complementary to the actual PIOT-ADV, with the scientific data exchange over the sustainability of the wine culture of both countries. The norms are related to ADV region and the Spanish *Arribas del Duero*, however, this fact does not imply that the identity of the Portuguese region is at risk (AA.VV. 2009). It is possible to understand the measures' focus on agricultural activities justified by its territorial expression however the related cultural heritage must be valued.

In 2001, the social and economical characterization survey of the ADV region municipalities (AA.VV. 2003b, 3) revealed the total ignorance of communities regarding the impact that the candidature could provide for them.

1.2. THE WINE CULTURE AS A STRATEGIC OPPORTUNITY

Besides the agricultural activity, the ADV landscape has the potential of being an important asset to cultural tourism, specifically rural tourism, a trend designated as Touring: *In Europe, the touring travels, in which are majorly integrated the tourism in rural environments, represent 44 million travels (about 18% of the Europeans leisure travels is included on this product). This touristic product has an important role in the design of the National Strategic Plan of Tourism (PENT – Plano Estratégico Nacional de Turismo (2007-2015)) that represents an increased trend in the order of 5 to 7% (AA.VV. 2008).*

The PENT (TP 2007) strategies focus on cultural heritage promotion and the creation of itineraries or cultural routes. The goal is to establish Portugal as a relevant competitor in this market segment. Touring demand is fuelled by the direct contact to local traditions and social rites in form of *agricultural tourism*, an approach that contributes to the sense of affinity and proximity to local communities. This is defined as a Software of Cultural Tourism Product, directed to conservation purposes (see Table 1).

In the case of communities with a strong agricultural base, this type of tourism has gained an increased importance. A significant number of farms (*quintas*) are part of the Wine Rout in the ADV region. The result is the region promotion by the Mission Structure and Douro Museum Foundation (see Fig. 9), operational since 2006, with free open-sessions to the general public, stimulating tourism, with activities as the wine tasting and farm tours, that otherwise remain closed to the public. It is important to refer that the Douro Museum is part, though a central one, of an integrated route of 11 museums, such as the Imaginary Museum in Tabuaço, open since January 2009.

Other initiatives have taken place such as *Caminhos Durienses* in 2001, with their panoramic sights tour promoted by the Northern Region Coordination Commission for Development (CCDRN – *Comissão de Coordenação e Desenvolvimento Regional Norte*) (Curado 2003).

The villages – *Barcos, Favaios, Provesende, Ucanha, Salzedas and Trevões* – were chosen in 2001 to integrate the *Programme Aldeias Vinhateiras do Douro*, supported by the AIBT and SPIDOURO. This programme has the goal to recover and invigorate a limited net of “reference villages” in the ADV region. In 2007, it was created a festival – *Festival das Aldeias Vinhateiras* – that celebrates local traditions related to wine rites supported by the northern regional operational programme within the National Strategic Reference Plan (QREN 2007-2013).

The strategy is clearly directed almost exclusively to tourism, in all referred shapes. The problematic is not new: the exhaustion of tourism as a resource, though valid, can paradoxically endanger the landscape (COE 2000).

In the case of the ADV Region, the strategy has been to develop and simultaneously preserve the wine activity with a clear investment in tourism. However, it is possible to affirm that the ADV region has been corresponding positively to its candidature purposes, with capable legislation, regulating entities and different partnerships.

MANAGEMENT ISSUES	HARDWARE of Heritage Site & Territory		SOFTWARE of Cultural Tourism Product		ORGWARE Agents and Organization	
Conservation vs. Tourismification	IN HERITAGE SITE SITE MANAGEMENT local	IN TOURIST DESTINATION DESTINATION MANAGEMENT regional	PRESENTATION & INTERPRETATION	TOURIST APPEAL & EXPERIENCES	PUBLIC & PRIVATE AGENTS POWER & INVOLVEMENT	STAKEHOLDERS LOCAL & GLOBAL INVOLVEMENT & INTERESTS
Conservation	Monitoring Physical impact Robustness - Fragility	Sustainable development of tourism infrastructure	Valorizing tangible and intangible heritage	Uses and affinity with the site	Awareness of sustainable tourism potentials	Inclusion & exclusion in decision making
Monitoring	Carrying Capacity	Tourist Space-use Patterns	Visitor centre - facilities	Visitor management	Business opportunities TOS	Connections & Disconnections Global - Local
Legislation					Ownership & Competition	Ownership & Stewardship
Development Local & Regional	Selection & Planning of Cultural Resources	Zoning & Clustering of TOS (Tourist Opportunity Spectrum)	Innovation & financial resources	Creativity & marketing	Motivation & incentives	Partnership

Table 1: Tourism Management Strategies (Jansen-Verbeke, McKercher, 2010).



Figure 9: Douro Museum, Peso da Régua (source: Ricardo Loureiro 2008)

2. CONCLUSION REMARKS

Actually, there are two significant tendencies of territorial intervention, concerning the heritage management (Veltz 2002, 10-11):

- The political strategies for the creation of various response models: although these strategies are based on the existent cultural assets, it goes beyond this aspect, anticipating future trends and productivities enabling the landscape autonomy and sustainability;
- Simultaneously, there is an awareness concerning the landscape conservation: different productive cycles in the major and potential sectors of cultural landscapes have to be considered.

Related to the first point, the PIOT-ADV plan has two major investment strategies already mentioned – agriculture and tourism – due to the wine activity common ground. These two activities are intertwined and support the landscape, and consequently, its communities. The question is: can it be a third window of opportunity, besides these otherwise obvious courses of action? The possibility of other viable strategies is a hypothesis that could be further studied crossing the data between these two sectors. The role of vernacular architecture in the communities as well as further dynamics, besides tourism, should be also explored.

Portugal strongly depends on European funds in order that many of this kind of projects can survive. It is also important to refer that entrepreneurship and the active participation of communities are real key factors in a management plan concerning patrimony. This is mainly achieved by partnerships between the public and private sectors. This is not always consensual though theoretically it should be.

Related to the second point, the ADV region has been, despite some problems along the way⁴, regulated by public entities from the GIT to the actual Mission Structure.

The ADV safeguard is built on people's awareness through education, so the local communities can understand and live the plan in its real significance.

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ENDNOTES

¹ Sebastião de Carvalho e Melo, Marquis of Pombal (Marquês de Pombal (1699 -1782)) as a prime minister was responsible for important public reforms, in various departments, from education to economy. He is also known as the main character in the public design of Lisbon downtown after the earthquake on the 1st of November of 1755 (Oliveira, 1990: 418).

² The LEADER+ program is a tool that allows experimenting diverse approaches concerning interventions on rural landscapes, respecting the environmental, economical, social and cultural aspects of rural territories. The LEADER+ program underlines the importance of local conscience, their identities and landscapes self worth. Consequently, it was created the conditions for the skills acquirement so the local communities have an active role and intervention. In April 14th, 2000, the European Communities Committee adopt, in according with the stipulated in the European Regulation (CE, 1999), the guidelines related to the rural development and local initiative promoted by LEADER+ (EU 2000). The LEADER+ program is a local initiative, financed by FEOGA-Orientation and by public/private entities. It is most active when combined with the Local Action Groups (GAL – Grupos de Acção Local) and the main goals are valuing the natural and cultural heritage, the economy reinforcement, creating jobs and the aid to local organizational abilities (AA.VV. 2003a).

³ The Instituto da Gestão do Património Arquitectónico e Arqueológico (IGESPAR 2009) is an institution, result from the merger (MC 2006) between the Instituto Português do Património Arquitectónico (IPPAR 2009) and the Instituto Português de Arqueologia (IPA 2009). It incorporates some of the attributions of the Direcção Geral dos Edifícios e Monumentos Nacionais (DGEMN 2009), meanwhile extinct. It's a public institution, indirectly administrated by the State, following the attributions from the Cultural Ministry on the sphere of cultural, architectural and archaeological patrimony. The focus of this entity is monuments preservation and the promotion of routes and tours in natural landscapes such as Fôz Coa. Despite this fact it was acknowledge the dissociation between landscape and monuments, a key factor to promote and protect cultural landscapes that must be viewed as a whole with a holistic approach (Oliveira & Ribeiro 2010).

⁴ Besides the already mentioned problems concerning the establishment of a normative entity, the fact is that ADV region struggled with other questions. In 2007, it came to the general public that ADV region could lose its UNESCO World Heritage status because of the major illegal dumps in the protected area. In 2010, this is still a problem. Consequently, the VALOR DOURO project was created to recover the fluvial landscape, supported among others by the Mission Structure. The causes are attributed to the lack of civic spirit and lower local education.

An Urban Crisis of a Financial Model: The Adaptive Reuse of Socialist Industrial Complexes in Moscow

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ABSTRACT:

Since the fall of the Soviet Union, Russia has transformed from a socialist state and communist ideology into a democratic state and a post industrial economy. The dramatic transformation of a society generated a concurrent transformation of the urban fabric. A transformation informed and sculpted by extremes; such as the sudden absence of an established social system and the application of a paradoxical one and the aspirations of a market economy which must struggle through the hindrances of a socialist past. Consequently, the physical transformation of Moscow, has been, and is sculpted by the extremes of the post-socialist vision of capitalism; which is fuelled by seventy years of repressed economic energy, an energy which compresses economic evolution. Compression distils out and eliminates critical processes required to reconcile economic and social potential that is essential for the liveability of the city. Instead, through the haste to transform, it allows uninformed preconceptions to flourish; preconceptions which ignore the evident and essential needs of a city. In this case, compression has allowed the potential, of urban transformation, to dissolve into a hybrid of economic equivocation and ambition. In Moscow, this hybrid has been imbued into the mechanics of the privatization of property, government management of land use and the priority placed on private developer interests. These private interests, lacking proper regulation, are characterized by; additional burden to the cities overloaded and failing infrastructure, the focus on short term profit at the expense of long term progress and the damage to the fabric of existing neighbourhoods through large scale insular developments. Through the lens of previously state held industrial complexes and their adaptive reuse this paper examines the transforming notion of public space, local identity and city life in the Post-Socialist City of Moscow.

CONFERENCE THEME: On Approaches

KEYWORDS: socialist, industrial, reuse, development

INTRODUCTION

During and shortly after the 1917 Bolshevik revolution, all urban land was appropriated by the state. This land grab was part of many social and government actions to support the ideology of Socialism and the creation of a Communist state. During the subsequent seventy years of Communist rule, this land was developed to propagate and celebrate socialist ideals where property was no longer privately owned and private space became communal. When the Soviet system fell, much of the state owned enterprises and the associated property became available for privatization. This abdication of state ownership, propagated by the dramatic change in governmental system and the demands of the market economy allowed uncontrolled development. Without a clear plan of the city, unplanned transformation allowed development strategies which promoted exclusivity instead of inclusion and isolation to accessibility. These tendencies were in direct response to the common citizen notion of what private and public space meant. The understanding of what constitutes public and private space is different in relation to western notions of space. Public space is viewed as owned and controlled by the state and subsequently represents forced communal living. The perception of public space is a reference to socialist times. Now, private space is viewed upon as a symbol of position and luxury, the ultimate freedom from the collective. Consequently many development strategies are driven by these preconceptions of the two types of space.

Moscow, like many Soviet cities developed in a predictable manner during communist rule. The industrial center, main transportation arteries and residential areas were mostly built before the revolution. The city expanded along the outer edges, where much of the dense social housing was built, leaving the center of the city relatively intact. By the 1980's, Moscow reached the limits of its

expansion to the outer ring road and its abutment to the surrounding administrative area; Moscow Oblast. After the fall of communism, the economy frantically grew, which was a result of repressed demand of over seventy years. This demand included a large appetite for property which coupled with the restricted supply quickly made Moscow property values some of the most expensive in the world.

Due to Moscow's rapid growth and development tendencies, over the twentieth century, many of the old industrial complexes remained and became imbedded in the city center. However, the dramatic transition to a market economy left many of these complexes vacant or underutilized. At the same time, the intense demand for land, limited supply and escalating value made the property more expensive than the value of the inhabiting enterprises. Additionally, because of the large percent of space they occupied in the city center, approximately twenty percent, their grandiose scale and unique character made these facilities prime targets for redevelopment.

I.0 POLITICS OF SPACE

In attempting to understand current spatial development trends in Moscow it is important to recognize the historical scars the Russian people still carry with them. For seventy years, life was ruled under a socialist regime. The notion of public and collective space was the base for imagining a utopian society. In contrast private domain was almost completely absent from the life of the Soviet citizen. We therefore postulate that the spatial responses of the city in the last twenty years, is in direct response to these notions of public and private space. Notions which are in direct reaction to the previous societies prescribed purpose of space. Driven by fear of the collective, the current city and its inhabitant celebrate the private. Anything "public" triggers a collective memory of Soviet times. It is therefore not a surprise that there has been a reactionary wave which has favoured the private realm. The ability to separate oneself from any interaction with people from different socio economical backgrounds is considered desirable in contemporary Russia. This tendency, typical to the average Muscovite, is not being vigorously challenged by the city's planning officials. However it is obvious the city as a whole is paying tremendous price for this desire. The isolation and exclusion has created islands of development, which through their insular approach has turned their back on the surrounding streets and the city.

I.1 SOVIET INDUSTRIALIZATION

In 1917, after centuries of oppression of the lower classes, a series of proletarian revolutions ended Russia's Tsarist autocracy. The efforts, of the working class, eventually led to the creation of the Soviet Union, one party state ruled by the Communist party. This new "Democratic Centralism", somewhat foreign to the ideas of the revolution, was justified by the leadership as a mechanism for insuring that 'capitalist exploitation' never returns to the Soviet Union. In the spirit of giving power to the working class the new state was the first one to adopt a planned economy. Under the new system the government was in control of the industry, directing all major decisions regarding production and the distribution of goods.

In the process of building the new socialist economy the control of all industrial enterprises was assumed by the government and a general process of industrialization took place. The industrial manufacturing complexes became central to the construction of the new society. They no longer represented places of oppression of the lower class; rather they played a key role in creating the new soviet man. Worker's clubs were established and provided not only opportunities to socialize but also played a major educational role, providing educational and cultural opportunities that until 1917 were available only to the chosen few. It is incomprehensible that "In 1917 Illiteracy was recorded at 75-85%." ¹

John Reed summed up the intense ebullience of proletarian life during the year 1917: "All Russia was learning to read, and reading - politics, economics, history - because the people wanted to know.... The thirst for education, so long thwarted, burst with the Revolution into a frenzy of expression. From Smolny Institute alone, the first six months, tons, car-loads, train-loads of literature, saturating the land.... Then the Talk.... Meetings in the trenches at the front, in village squares, factories...What a marvellous sight to see: Putilovsky Zavod (the Putilov

factory) pour out in its forty thousand to listen to Social Democrats, Socialist Revolutionaries, Anarchists, anybody, whatever they had to say, as long as they would talk! For months in Petrograd, and all over Russia, every street-corner was a public tribune. In railway carriages, street-cars, always the spurting up of impromptu debate, everywhere.... At every meeting, attempts to limit the time of speakers voted down, and every man free to express the thought that was in him".²

It wasn't only the industrial facilities that were assumed control by the government; the same was true for all real estate, including housing. The communist party therefore assumed responsibilities for all aspects of one's life. It was expected to provide all members of society with housing, healthcare, education and work. In return people unwittingly paid with their freedom to choose where to live and what to think.

1.2 PRIVATE DOMAIN

For the greater part of the 20th century, and in a much smaller scale until today, Russian families living in urban areas had to share with complete strangers the most intimate space of all, their homes. *Kommunalka* a "communal apartment" was an apartment shared by multiple families, often from very different backgrounds, brought together merely by the arbitrary decision of the government. Multiple family members shared a single room while the rest of the house, bathroom, kitchen, hallways were shared by multiple families. Forcing together people with different ethics and life habits, it is no surprise that these public domains were highly contested public spaces.

Communal living was first and foremost a social policy, supported by the increasing need for housing in a state of rapid urbanization. This policy created a mechanism that not only promoted the socialist values of collective living but was also an easy way to insure that no anti government activity is taking place in the private domain. Often infused with informers, all apartments were subject to government control. Suspicions and lack of trust were common for most of the soviet regime years, since denunciation was possible not only by neighbours but also by family members. The general notion of privacy was condemned - "Soviet man has nothing to hide from its comrades"³, subsequently individualization was delegitimized. Hence, during the seventy years of the socialist government, there was never really a clear boundary between public and private. To some extent all could be considered public, since "privacy" could only exist as isolated moments in space and time and could be exposed and condemned at any time.

"Like electrical condensers that transform the nature of current, the architects' proposed 'social condensers' were to turn the self centered individual of capitalist society into a whole man, the informed militant of socialist society in which the interests of each merged with the interests of all"⁴

It is not a surprise then that with the fall of Soviet state the level of "privacy" one could achieve was associated with his new status as a free citizen. So while it's not unusual to see separation between people of different financial background, in Russia this notion reached new heights. Fences, extensive security systems, exclusive clubs and the almost complete withdrawal from the public realm of city life are just some of the reaction of Russia's new rich to their new freedoms.

1.3 PUBLIC DOMAIN

Throughout history, Russia has emphasized and celebrated the Civic space. Grand boulevards, endless plazas, and overpowering monuments are a common seen in the Russian landscape. However, "Public Space" is not the same as civic space. Public space is created by the nuance of activity which fills the space because of its self. It is the activity of use within a space which allows one to observe and be observed. It allows for a variety of use with brief moments of organized and singular activity, but without the space necessarily having been designed for a singular common focus of the inhabitant.

Notions of public and private vary considerably across different cultures. In Russia the common experience of these notions can't be separated from its past of communal living under the close supervision of the soviet state. In contrast to the western notion of public space being a realm that is equally accessible to all members of the society. When a Moscow official was asked to present his notion of public space he said:

“Public Space”- is “Everything what is actually owned by the state”. If you asked the mayor of Berlin, Amsterdam, New -York or even of Hong-Kong, you would barely get the similar answer. “Public Space” is something where different stake-holders come into share and have to negotiate their roles. I think this is something that Russia still has to understand.”⁵

Capitalism, greatly transformed the soviet city, and with it has changed the socialist notion of public and civic space. This took place primarily through two main processes; privatization and commercialization. Privatization seems to have isolated and segregated the inhabitants of the city, reducing the opportunities for public, where commercialization has activated many of the sterile civic socialist spaces.

When you have an empty space and you fill it, it does not mean that you have eliminated the void. You can fill the space and create more void than if you had not built at all.⁶

Daniel Libeskind

As the Soviet system fell, privatization and development arrived and moved forward at a rapid pace in contrast to the Soviet city, which was explicitly planned with public and civic space, recent development has done little for the overall planning of the city. Through the process of privatization the city has become more and more isolated. Much of the land that was owned by the state and was considered public quickly became available for privatization. A process which was fundamentally flawed, since the value of the land and enterprises could not be easily quantified coming from a planned economy; where the value of property was stated through government decree instead of through market economy processes.

The basic problems of privatization in post-socialist countries are aptly summarized in a witty aphorism credited to Janusz Lewandowski, Poland's Minister for Ownership Changes in 1991: “Privatization is the sale of enterprises that no one owns, and whose value no one knows, to buyers who have no money.”⁷

Ideally, privatization is accomplished through three broad categories: *divestment*, *displacement* and *delegation*. *Divestment* of a business is the selling, donation as a business or liquidation by selling the assets. *Displacement* allows the government to be replaced over a period of time by private enterprise. *Delegation* is the management over the private sector in the production of services or goods. Because of much confusion and limited or no legislation during the beginning of the 1990's, these three privatization techniques mutated into something called *Spontaneous Privatization*.

This process involves leasing the firm's assets at a cheap price to a newly created private firm that belongs to and consists of the enterprise's senior management, or even selling the enterprise to a foreign firm in a self-serving, questionable and possibly corrupt transaction. This is tantamount to simple appropriation (actually, misappropriation) of the state enterprise by the managers.⁸

This unscrupulous practice is now outlawed, but not after a large percentage of state property was appropriated. The benefactors became part of small group of extremely rich property owners called the “Economic Elite” or Oligarch's. These players are very much the mechanism of real estate development in Moscow and a group whose primary focus has been short term profit at the expense of long term sustainability.

The decline of centralized power has created small independent units resulting in fragmentation and isolation of the urban fabric. Furthermore, because of developer desires to increase density, these independent units have overloaded the existing infrastructure of the city. The result has been the dramatic rise in traffic and the increase of demand on utilities and city agencies. While the profit from these developments goes to private owners, any upgrade to the city's infrastructure is a collective cost that everyone will have to pay.

2.0 CITY PLANNING

Moscow has been working without an official zoning plan for many years, allowing arbitrary decisions of development. These decisions are usually influenced by the desires of private developers and many times done through questionable interactions between developers and city officials. Because the vagueness of the zoning laws, the city has been working on the development of an official zoning

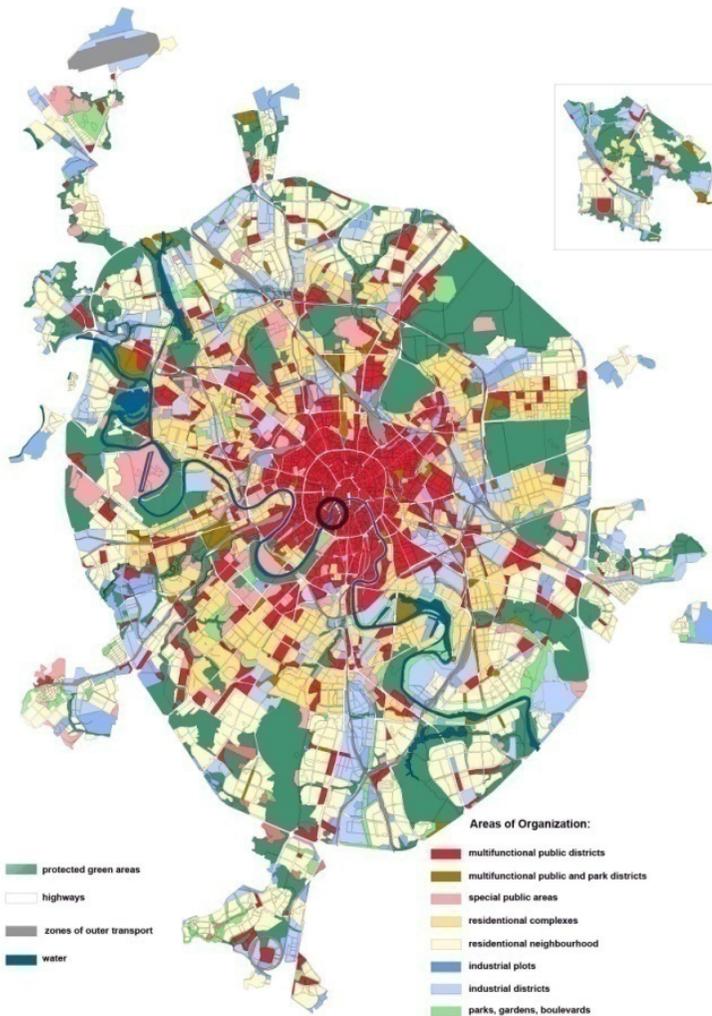


Figure 1: Moscow GenPlan 2025 (Strelka, Berlage Institute 2010)

plan for over ten years. In May 2010, a new development plan was approved for the city. This plan, referred to as Genplan 2025, see Fig. 1, promised quality housing, better roads, longer subway lines, more public space and the preservation of the historic center. Through the new zoning strategy, the plan divided the city into two parts - a stabilization zone and development zone. The stabilization zone includes the old residential areas in the city center and plans for substantial infrastructure development and repairs. Development zones include old industrial districts and existing five-story housing blocks of which are to be largely demolished to make room for new development.

The release of the plan was immediately followed by heavy criticism. Many arguing the plan was illegal and a “death sentence” for Moscow. It is projected, that if executed, Moscow will see 200 million square meters rise and 5 million square meters will be demolished. According to Anton Belyakov, State Duma deputy from Fair Russia party; The demolition will include as many as 300 monuments, while leaving the future of another 1,500 at risk.¹¹

The reality of the plan was the hidden influences and financial desires of private developers were revealed. Because Moscow has a limited administrative boundary; only through the substantial increase in building density, at the city's center, could the financial aspirations of the developers be met. A density which could not possibly be supported by the existing infrastructure of the city and even through proposed increases in roads and metro extensions would only serve to demolish and destroy the historic fabric of the city. See the red zones in Fig. 1. Mikail Blinkin, traffic expert, explained the burden resulting from continued development of the city center;

I'll give you the simplest example. We demolish five-story buildings from the Soviet times and put up a 30-story building in their place. The surrounding transport network, for cars and public transportation, we leave unchanged.¹⁰

Currently many businesses, to avoid increasing traffic and expensive rents are looking for new opportunities outside of the city center and in the surrounding administrative zones of Moscow Oblast.

While the city was trying to evaluate the plan for its future, a dramatic change took place in the Moscow government. In October 2010, Sergei Sabyanin, was nominated as the new mayor, replacing Yuri Luzhkov the mayor of 18 years. His immediate response was to suspend the implementation of the GenPlan and further analyze the needs of the city. As of this time a new proposal appears to be a few years away.

3.0 INDUSTRIAL SITES

The transformation of former industrial sites has been going on in the US and Europe for almost 50 years. In Moscow however this is a new process, one that is taking place in a unique context, between the fall of the soviet government and the ongoing world financial crisis. The current process is being shaped by an architectural heritage crumbling under the race for the new.

Many of the industrial sites which were built in the previous century became part of the city center. These zones occupy about twenty percent of Moscow's territory. Because of the high demand for property, these facilities have been and are targets for redevelopment. The dilemma the production companies faced was the entities were not as valuable as the property they occupied. Economically there was a need to move these facilities out of the center of Moscow, since any attempt to refurbish them as manufacturing facilities was financially unprofitable.

Today, the logic of the new market economy exerts strong pressure for the redevelopment of these sites to other uses, especially in the more central parts of the city (the sales value of land inside the Garden Ring in 2005 was estimated at over 8,000 USD per sq m). These development pressures already started to push out industrial uses to the periphery where they could be accommodated on new greenfield sites with lower land rents and plenty of relatively easily accessible space.¹¹

Within these types of facilities there are three levels of quality and financial investment; the elite high end, class B Business and low end Soviet Era facilities.

These industrial buildings are usually rated class "B" grade buildings. The most common approach to reusing these facilities is business and high end residential developments. Rarely are these facilities considered class "A" buildings; which is usually held for brand new construction. Because these facilities held industry, sometimes heavy industry, the buildings are perfect for adaptive reuse. Large spacing of columns, tall floor to floor heights and overbuilt structures allows these buildings to easily support most types of program. Usually these buildings are in a complex of buildings, a campus of sorts. Under socialist times the allocation of space needed for these facilities was not based on market value of land, but the determination of government officials. Therefore, many of these complexes are of low density in comparison to the surrounding city. This is the primary reason why the complexes take up such a large percentage of urban land.

As pseudo campuses, these complexes are usually redesigned by keeping or enhancing tall barrier walls along the street and sidewalk. These are only interrupted by locked gates for vehicular access, which security personnel continuously patrol. Additionally, access into the buildings entrances are secured by both guards and a security pass system. Within the complexes, most open space



Figure 2: Danislavsky Dvor. Source (Author, 2010)

is consumed by parking; ignoring the potential for a pedestrian campus. An example of this is “Danislavsky Dvor”, (Fig. 2).

David Harvey and Matteo Pasquinelli have pointed out that the creatives often play the part of the bait in complex real estate operations that ultimately aim at the substitution of the creative ‘pioneers’ with bourgeois ‘gentrifiers’.¹²

Recently, a number of developments have used the arts or academic community as initial inhabitants. Their use of the facilities generates interest and activity and therefore increases the value of the properties. Ultimately, however, the facilities are gentrified and the creative class gets pushed out once the value of the properties increase beyond the means of the initial inhabitants. The following projects show different attitudes towards the use of cultural program to instigate development in these types of facilities.

The Bakhmetevsky Garage 1926-27, by Konstantin Melnikov, see Fig. 3., is now a non-profit exhibition space dedicated to the promotion and development of art and culture. This facility is maintained by outside private funding and is a model of cultural development which has saved a significant piece of Russian modernist architecture and promoted a cultural program. This is a top down approach and ultimately is dependent on the good will of the economic elite.



Figure 3: The Bakhmetevsky Garage (Author 2010)



Figure 4: Proekt Fabrika (Author 2010)

The second example of cultural development is Proekt Fabrika, which is an active manufacturer of paper used to print images on porcelain. It is the only factory of its type in Russia. The unused parts of the factory were changed to cultural production when there was a reduced demand for various paper products. A number of the lines were eliminated and factory space became available. The head of the factory decided to introduce cultural program in 2004 to use the extra space. The profits of the paper support the galleries and visiting artists. It is a non-profit art center and completely independent of city government and outside funding. This allows an autonomy that many of the art centers through the city do not enjoy. They have also joined partnerships with art organizations outside of Moscow, in Europe and the United States, such as the NYC gallery Sputnik.

The last and largest development, using cultural program, is the Red October Chocolate Factory (Fig. 6) on Bolotny Island. It is one of largest industrial complexes going through adaptive reuse in the city. The development has been placed on hold primarily because of the global financial crisis. Initially the island was meant to be turned into a luxury residential zone, called Golden Island, and was to house only the extreme rich in large private residences. However, because of the credit crunch, it has allowed a small artist community to inhabit the facility at a very low rent and even more importantly the complex now holds a new school of architecture, Strelka Institute of Media, Architecture and Design. It is a post graduate school, with a curriculum designed by Rem Koolhaas. Both cultural programs are initiators to the development of the complex and have brought recognition and interaction into the facility. Additionally, the complex has created a social hotspot by bringing in nightclubs, restaurants and bars. Since the complex is in the middle of the city and adjacent to many of the major landmarks of the city, there is intense pressure by the public to develop this site with long term solution to public access to privately owned property.

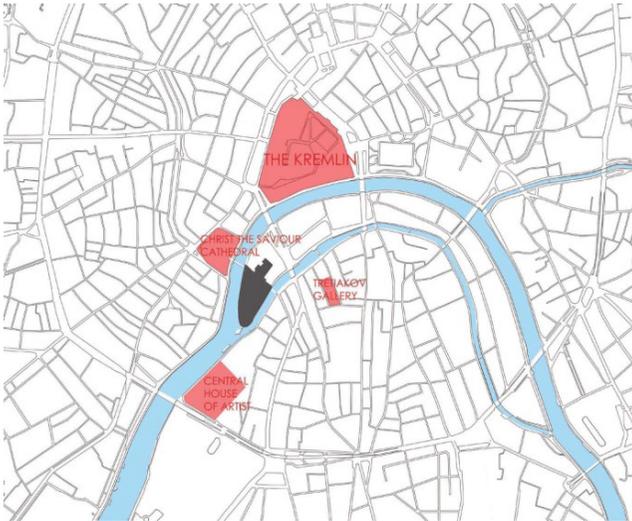


Figure 5: Location of Red October (Strelka, Berlage Institute 2010)

What is additionally interesting about Strelka and Red October is that the investment of the rich is focused not only on the financial viability of the complex, but it also the education of a new generation. It is a unique approach to these types of developments and is beyond the standard approach seen throughout the city to this point.





Figure 6: Red October, Confectionary Factory (Author 2010)

CONCLUSIONS

The question of what kind of city we want cannot be separated from what kind of people we want to be.

David Harvey

Socialist industrial complexes in their historical role as well as in their current state of transformation can be viewed as political, economic and social microcosms of the Russian society. Dominant in the urban landscape of the capital city they played a central role in shaping the urban life in Moscow for most of the twentieth century. Constructed as industrial manufacturing facilities, they supplied jobs for thousands of people and at the same time played a social and symbolic role in shaping the identity of the soviet man. With a primarily autarkic economy each facility was responsible for a specific product. From chocolates to cars everything was “USSR” made and a source of national pride. Growing to inhabit almost twenty percent of Moscow’s land these facilities became central to shaping the urban fabric of modern Moscow. Developed with minimal land limitations, they were often oversized, centrally located and impossible to miss.

Originally conceived as mechanisms of collective productivity and symbols of proletarian power, these facilities are now being turned into introverted islands of capitalist illusions. From spaces that celebrated the state ideology and at least conceptually belonged to the working class people; they have now, following the collapse of the USSR, have been almost fully privatized and isolated from the public.

In a desperate attempt to catch up with western capitalism, the Russian economy puts everything up for sale. An economic evolutionary process that took the west almost a century is being compressed in Moscow into several years. While a long term plan is yet to be finalized and approved by the new mayor development has only temporally slowed down by the global economy.

More often than not the industrial facilities, once privatized, are developed with very few substantial limitations from the city. With no considerations of their impact on the existing local fabric, public accessibility, or the city infrastructure that will be required to support them. They are like parasites, taking what they can and turning away. Taken away from the working class in the nineties, they are now being taken away from the city as a whole.

As reflected in current trends of development, Moscow and its inhabitants are experiencing a psychological barrier, a post soviet trauma. Still blindly reacting to its past, Moscow assumes conflict between public and private space. However, it is possible that in these facilities, embedded with meaning, the preconceptions of what constitutes space can be re-imagined and the imprint of a societal trauma can be slowly erased. Through actualizing the integration of public and private,

Muscovites can experience a different kind of public space. One that brings together people through chosen and desired interaction and not through programmed government and a top down approach.

Finally, only twenty years after the fall of the soviet state Moscow is experiencing yet another major transition politically, economically, and culturally. Through the global financial crisis, which has placed much development on hold, and an appointed new mayor who is willing to challenge previous assumptions, there is a small respite and an opportunity for the city to take a breath and plan its future. As the economy has cooled down, different and more nimble approaches to development have started to appear. Possibly, as seen in the Red October factory and Strelka these places can be points of culture, entertainment and most importantly discourse. These approaches are harnessing a younger generation of citizens who do not have the psychological barriers of the past and are questioning the biases of the previous generation. “What type of city does Moscow want to be?” should be a question asked as transformation of industrial site continues to reshape the life of Moscow.

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Traveling Michel Serres' Passage du NordOuest: what happens, once the ice breaks?

A reflection on architectural research conducted
between the humanities and engineering.

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ABSTRACT:

This paper investigates the complex design process for sustainable buildings mediating between spatial composition and architectural typology on one side and thermal, climatic conditions and energy use on the other hand. The theoretical base is *Hermès V Le Passage du Nord-Ouest* (Serres, 1980) by the French philosopher and mathematician Michel Serres (1930 -), where he is searching for a passageway from the exact sciences to the arts and humanities. While both are looking to explain the world with their own methods, they are turning their backs at each other. The shipping passage in the North of Canada connecting the Atlantic and the Pacific serves him as a metaphor for this complex thought space linking, connecting and dividing, these two explanations of the world. This text is dealing with the connection of places, which seemingly are separate: rigidity and phantasy, myths and exactness, quantitative and qualitative knowledge. Based on this understanding the paper analyzes the design process between architecture and engineering as a passage passing four overarching theoretical frames crossing between geometry and perception, drawing and material, atmosphere and typology, technology and desire thus befriending quantitative and qualitative methods of design thinking. The research analyzes a built experiment, the Interlock House, which focused on the relationship of spatial composition and air flow as a means of energy transfer, the impact of passive and active environmental controls and systems on architectural design and improved building energy performance. The means to travel the passage: proportions, thermal detailing, natural ventilation strategies and daylighting are here identified as key moments for sustainable design. Design communication for sustainable buildings needs to convey information between multiple entities with opposing language systems and thus equals a map rather than a flow chart. A collaborative design methodology emerges from these passages when the ice breaks.

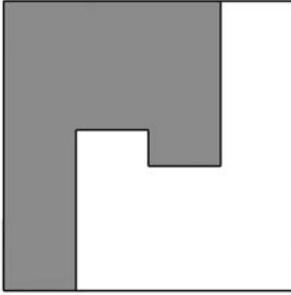
CONFERENCE THEME: On Approaches

KEYWORDS: Design Communication, Sustainable Buildings, Integrative Design Thinking, Interdisciplinary Collaboration, Natural Ventilation

I. INTRODUCTION: RESEARCH THE PASSAGE DU NORD-OUEST

Open space architecture which is well-tempered in light, color, materiality and space can become a climate device to make daily life comfortable and sustainable. The presented research is a continued analysis (Passe 2007) of the complex relationship between spatial composition in free-flow open space typology on one hand and thermal and climatic conditions within buildings on the other. It asked how spatial design theory of transparency in space can contribute to and enrich the development of sustainability and the reduction of energy consumption in buildings. The research started with a re-reading of selected architectural icons of modernism which use free-flow open space through diagrammatic drawings and simulations with computational fluid dynamic (Author 2009) and proposed and built a solely solar powered house with a large interdisciplinary university team to develop design strategies for sustainable buildings.

The name of the Iowa State entry to the U.S. Department of Energy Solar Decathlon, the Interlock House, provides the starting point for implementing the design strategy. Within the project, the concept of 'interlock' had many meanings: the spatial integration of active and passive environmental control systems; the densification of urban neighborhoods by adding new housing units to existing



INTERLOCK HOUSE

Figure 1: Design diagram: Interlock House. (Team 2007)

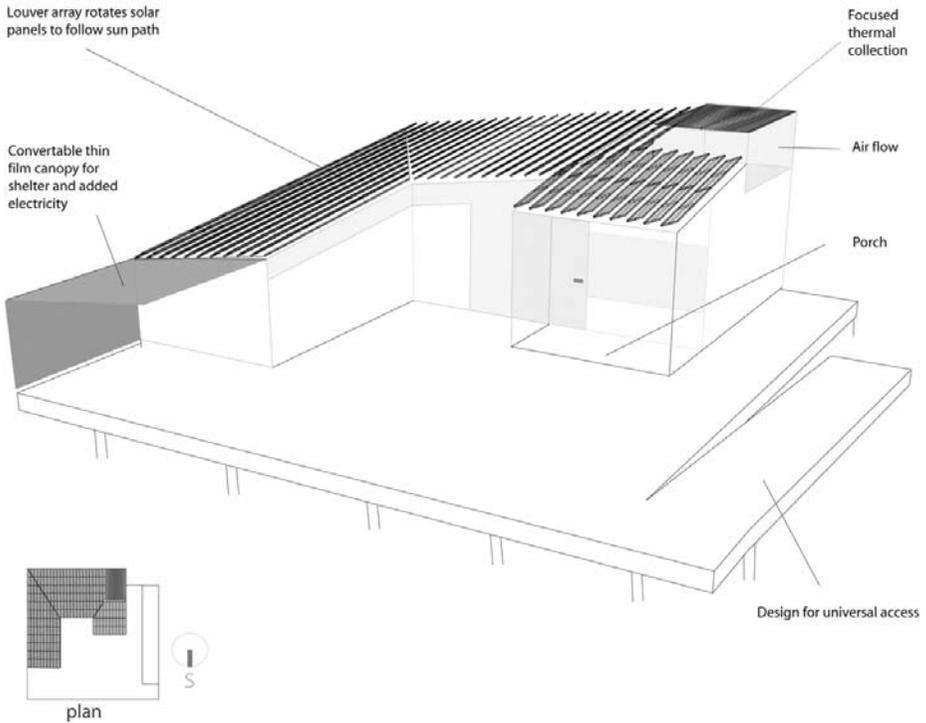


Figure 2: Three-dimensional design diagram. (Team 2007)

fabric; an active connection between the occupant and their landscape and climate; the relationship between the two main processes of energy conversion - thermal and electric; and the multidisciplinary nature of green building design which brings together architecture, engineering, science, and art. The Interlock House is designed as a climate device. The design process to derive at this house was an interlocking communication and translation system, which connected parameters on various levels of disciplines, construction techniques, and thermal properties, climate of seasons, user patterns and comfort requirements. A process of translation developed across the disciplinary boundaries.

The French philosopher and mathematician Michel Serres (1930 -), in Hermès V Le Passage du Nord-Ouest (Serres 1980) is searching for a passageway which leads from the exact sciences to the arts and humanities. While both are looking to explain the world with their own methods, they are turning their backs on each other. The shipping passage in the North of Canada connecting the Atlantic and the Pacific serves him as a metaphor for the complex thought space linking, connecting and dividing, these two explanations of the world. This text is dealing with connections of places, which seemingly are separate: rigidity and fantasy, myths and exactness, quantitative and qualitative knowledge. The Northwest Passage serves here as a metaphor for the complex design process between disciplines needed to produce and perceive sustainable architecture.

2. METHODOLOGY

This paper analyzes the design methodology of an interdisciplinary team while designing the Interlock House as a passage between architecture and engineering through four overarching theoretical frames crossing between geometry and perception, drawing and material, atmosphere and typology, technology and desire thus mediating quantitative and qualitative methods of analysis. The means to transverse the frames are passage culminating in the design effort as a synergy of hard and soft facts (Connor 2009). For sustainable design these passages are proportions, thermal bridge detailing, natural ventilation and daylighting.

This methodology opens the potential for a new interdisciplinary design thinking where the harsh communication boundaries between the disciplines and dialectics are broken up and a singular architect as author is replaced by a jointly working team. Neither of the passages can exist without either side of the frames.

The 2009 Solar Decathlon competition measured and evaluated each house in five subjective and five objective contests which is comparable to a travel through the Northwest passage. The subjective contests evaluated architecture, engineering, market viability, communications, lighting design and the objective contests comfort zone, hot water, net metering/energy balance, appliances, home entertainment were measured with built in instrumentation. Some contests were task based such as hot water and appliances. Other contests such as comfort zone and net metering were directly measured throughout the course of the competition time. Each house was equipped with shielded temperature and humidity sensors to measure interior air characteristics. Bidirectional wattnodes and current transformers were used in each house to determine the overall energy balance. Sensors were also placed in the center of the exterior competition site to measure environmental temperature, humidity and insolation on a horizontal surface. The competition assigned points based on how well a team met the criteria for each of the ten competitions. Specifically, full points were awarded in the comfort zone competition for maintaining an internal temperature between 72°F and 76°F and maintaining an internal relative humidity level between 40% and 55% during all scoring periods.

The design process can also be read as a performative map representing a house which creates its own thermal environment. The design team was using simulation and modeling maps to understand and communicate the energy performance and thermal and visual quality and atmosphere of the house at the same time. The central entity, bringing all these assumptions together, is the spatial configuration of the house based on the spatial concept (Fig. 1 and 2) of efficient and generous distribution of the collected heat energy which manifests itself in section and plan of the building. The spatial concept balances the need for a tilted south-facing surface for the photovoltaic array, the use of thermal heat and cooling vents and the capturing of energy with the envelope and thermal mass. It incorporates natural air flow and ventilation strategies to enhance comfort and thermal balance. The interrelation

of all parameters manifests itself in a balance of flows. A strong feature therefore is the exploitation of natural convection to create vertical flows. Material flows, energy flows, air-flows, and the movement of inhabitants are intrinsically and spatially related.

In the following the process will be narrated by first indicating the duality of the frame followed by the passage, indicating the design means which opened the connection. As with Michel Serres, the passages are attempts to communicate between two seemingly unrelated opposites.

Michel Serres' travel agent for the Northwest Passage is Hermes, the messenger of the Gods in Greek mythology. In secular terms Serres describes the interaction of qualitative and quantitative information as a process of language, which translates or maps back and forth between the domains. Thus the passage is opened with communication. Every participant breaks the ice. Hermes is also the god of travelers and merchants, the messenger from gods to humans, thus also the god of communications. Michel Serres is suggesting that the Northwest Passage between science and humanities is communication, learning each other's language and respecting each other's contribution. The concept of translation, the in-between is what is important to understand and connect the opposing sides. No single team member incorporates all necessary knowledge, thus team collaboration is necessary to break the ice. The passage is open when participants do not turn their backs at each other, but face each other and share a common language and goal.

The common language between Engineers and Designers in the process to develop a sustainable building is a performative map or model, which acknowledges quantitative and qualitative knowledge as essential parameters to understand and research architectural phenomena and the communication within an integrative design team can make it apparent to all parts. Design teams have to develop a decision making processes without a singular decision maker, which is more similar to maps rather than hierarchical flow chart! And it is equally important to agree upon joint evaluation criteria and parameters for a continued mapping of the decision process as it is to identify obstacles and conflicts.

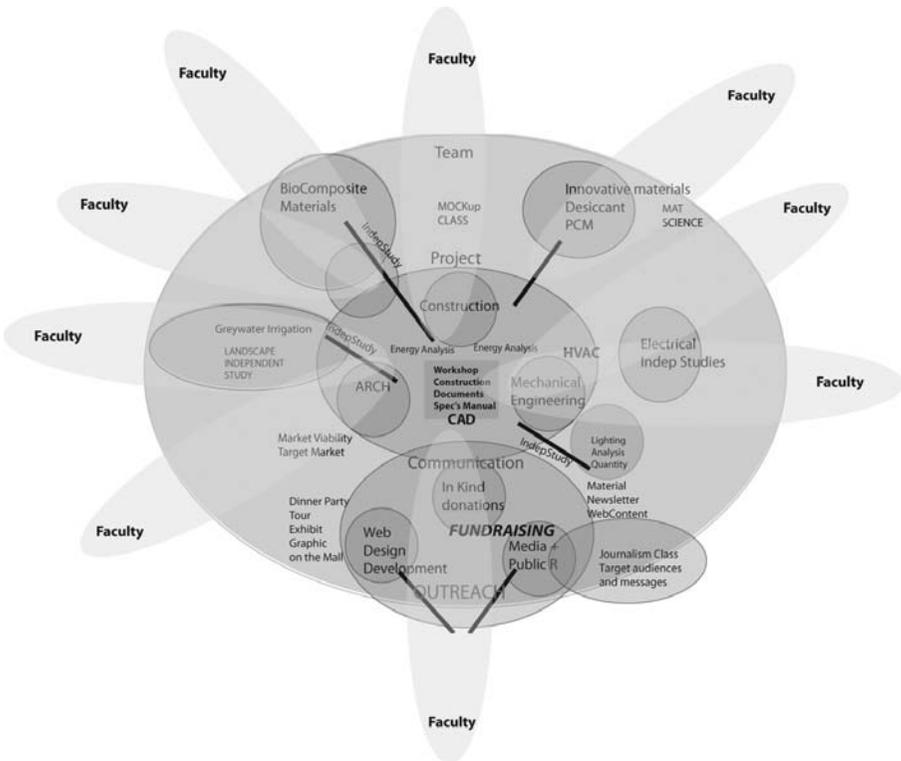


Figure 3: Map of team organization (Passe 2009)

The team organization diagram (Fig. 3) developed was not hierarchical, but mapped a spatial relationship of responsibilities rather than a chain of directions and orders. The formal outcome of the team work is not predetermined as can be seen in the comparison of the initial design sketch (Fig. 1+2) from the proposal stage and the final built form (Fig. 4-6). Michel Serres traces in the Northwest Passage relationships between the Global and the Local, between global meteorological patterns and local climates. This paper attempts to trace these strategies within the design process.

3.FRAME: GEOMETRY – PERCEPTION

This first frame addresses the mechanisms and modes of production going to and fro and thus bridging the gap between theory, design studio and practice, between analysis and synthesis. As Serres points out, synthesis retains connective thinking (Serres 1980). In this frame geometry and perception are connected with the passage of proportional relationships.

3.1 GEOMETRY

The means architects rely on to develop and describe an architectural project is geometry, the science of properties, relationships and measurements of points, lines, curves and surfaces. It is an exact but completely abstract and immaterial science with-in mathematics. Space in its dimensions is thought to be defined with geometrical means. Geometry could be seen as the underlying alphabet for the language of space with its grammar and vocabulary of proportion, compositional rules, harmonies, disharmonies, elements, notations (Passe 2007).

The Interlock House was designed by drawing a three-dimensional grid into space as a system of orientation and a proportional relationship for all elements in the interior and exterior of the spatial composition (Fig.4). The Interlock House is a small house designed to feel roomy. Composed of three spatial modules, the private zone of sleeping and bathing is located in the western third, with the Kitchen and everyday dining in the eastern third. The center is a luminous Hall and a Sun Porch enclosed on three sides by easily movable walls that separate or link activities within these zones or to the decks outside to offer multiple and reconfigurable patterns of inhabitation within a compact, energy-efficient footprint.

Adjusting the house to suit the weather also allows for seasonal changes in lifestyle. For example, the Hall is protected in winter by the closed Sun Porch, which warms the house (Fig.5). In winter, activities may re-focus inward and the furniture can be re-arranged to fit patterns of living at that time of year. The wide range of climate conditions in Iowa with design temperatures in winter of -6 degrees Fahrenheit and 90/74 degrees Fahrenheit in summer create special design challenges and opportunities.

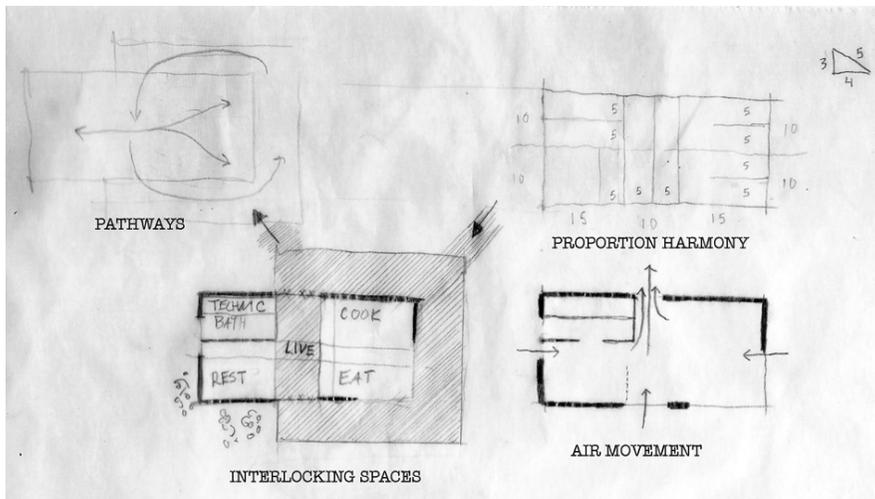


Figure 4: Conceptual sketch of house geometry. (Team 2008)



Figure 5: Seasonal patterns and spatial types (Team 2009)

3.2 PERCEPTION

Space cannot be perceived; what one can perceive are the borders of space, the edges, the thresholds, the materialization of the limits of space, the limitation of space makes it visible. The human visual perception therefore is not geometrical but spatial, such as the two eyes produce two separate images on the retina, which the brain merges together and through the slight difference of the two images we can estimate and perceive dimension, distance and space (Passe 2007).

The Interlock House is solely solar powered and full of light and air. Designed with high north clerestories and interlocking spatial volumes, daylight and artificial light wash the walls and ceiling, animating their sculptural quality, making the interior appear larger and brighter.

3.3 THE DESIGN PASSAGE CROSSING: PROPORTION

Spatial proportions are indicated by harmonious relationships of parts to the whole. The Golden Ratio and the Fibonacci Spiral are powerful tools to create basic harmonies based on the mathematic principle, that if two ratios are equal, their cross-product is also equal. Based on musical harmonies related to the human body proportions in architecture are indicators of beauty since antiquity. All major measures in the Interlock House are based on the ratio of 2:3 or 2:4 or fractions thereof (see Fig. 4 + 5).

4. FRAME: DRAWING – MATERIAL

This frame discusses the translation process between the concept of the drawing and the construction process. This is the most common but complex interface between soft and hard facts known in architectural production.

4.1 DRAWING

For multiple centuries the key skill of the architecture profession was to put lines and signs on paper. The key artifact and method of investigation of the architect has been the drawing and anything connected to the making of it. Drawing is thinking with a pen and now with a mouse or touchpad. Designing is a process of transforming to fit the artifact on paper to the thought of the mind. Drawing is a means to bring geometry in relation to perception, to work out relationships in space. The paradox of architecture is the translation process into building, into materialization, into a structural, spatial entity. While the method of drawing, whether perspectives, orthogonal projection, axono-metric view with real measurement and proportion informs the design of the space, the distortion of proportions through the perspective perception of the built form informs the user (Passe 2007).

Contemporary Computer Aided Design or Drafting has changed the potential for team work. A set of drawings on vellum has been replaced by a digital model, which carries multiple layers of information *and* final drawings, renderings and perspective views, the decision for which can be made *after* the model has been completed. Designing with CAD demands a totally changed discipline of drawing,

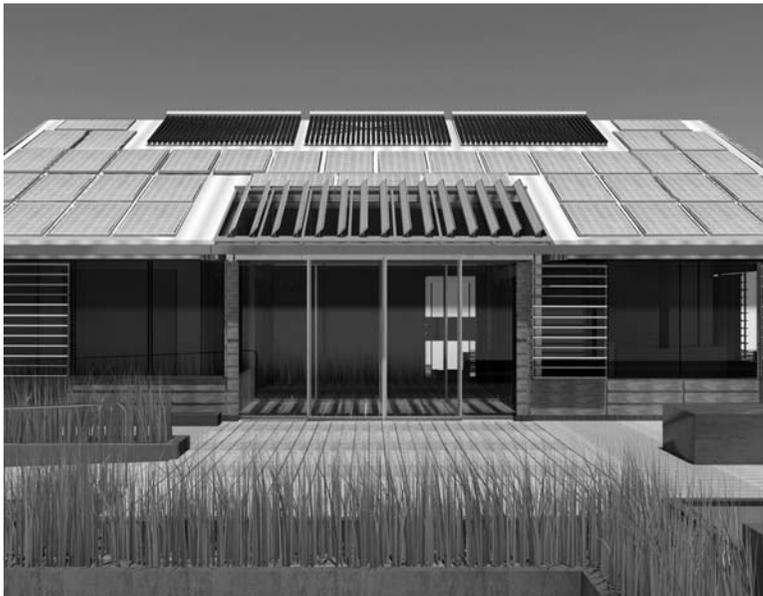


Figure 6: Rendering of south facade conducted in architectural media class ARCH 436 (Kiel Uhl 2009)

RAISE WINDOW SILL TO 30 INCHES (SOUTH WALL) -- **KEIHLY, DARCI**
SOUTH WALL RAFTER DETAIL--CHANGED --**ANDY**
WASHROOM--SECTION--DETAILED --**MELISSA**
STRUCTURAL--ADJUST --**ANDY, DARCI**
LIGHTS & CHILLED BEAMS--UPDATE TO MOST RECENT --**DAVIS, JENNIE**
REDRAW ALL SECTIONS--**DARCI**
SITE PUT IN TO ALL SECTIONS AND PLANS--**BRENT**
FLOOR PLAN--LAYER MANAGEMENT (LAYWALK) -- LAYER WALK ON ALL REF DRAWINGS--**ALL MANAGERS**
ADD LOFT IN CLERESTORY PLAN--**TRAMANH**
FLOOR PLANS MUST BE REFERENCED CORRECTLY--ENTIRELY GRAY WHEN REF'D --**BRENT**
DETAILS -- REORGANIZE -- MAKE CURRENT IN ALL DRAWINGS--**MELISSA**
SHEET GRID ADDED (DIFFERENT THAN STRUCTURAL GRID)--**ANDY**
LABELS --CLEAN UP AND CLARIFY THROUGHOUT--**ALL SHEET MANAGERS**
NEW WINDOW SIZES THROUGHOUT--NORTH CLERESTORY, WINDOW ABOVE SUNSPACE (TIM), SOUTH WALL--

Figure 7: CAD Sheet management (Team 2009)



Figure 8: Visualization of heating and cooling system embedded into the building fabric. (Andrew Becker 2009)

which is more process based than task based. Building Information Modeling provided the basis for this interdisciplinary team to collaborate and also conduct the translation from drawing to building through the three-dimensional model (Fig.6-8).

The organization of the drawing set to communicate materiality and to communicate a spatial reality and perception was the key to the travel of the Northwest passage, thus to design. The organization of the digital construction documentation demanded a linear hierarchy, but needed a spatial mapping structure.

4.2. MATERIAL

The making of architecture is the manifold translation process from drawing to material; it includes the material sciences, engineering, fabrication techniques and so forth. Any material ages in time, with natural materials, like this white cedar shiplap façade, this process is very obvious and visible. But also concrete, steel and even plastics react with the atmosphere. Lightness or heaviness are assumptions due to material joints, the way foundations are detailed, roof lines are put together, edges of openings are outlined, ideally to meet the concepts depicted in the drawing (Fig. 9).

The learning of this translation process in architectural education has multiple challenges, both from within and from outside of the disciplines, for example from the construction industry. Detailing the making of a joint is not considered part of the architectural challenge. In this case, the detail had to be developed and the materials found as the team was also the building of the house.

Very few tools exist, which can support a design team to determine the sustainability of a material decision. Many questions had to be answered to determine priorities. It had to be determined, whether the material should be natural, easy to handle, recyclable or renewable or how much waste is produced. The life cycle of a building and its 'cradle to cradle' approach was introduced as equally important design decision making parameter (McDonough 2002).

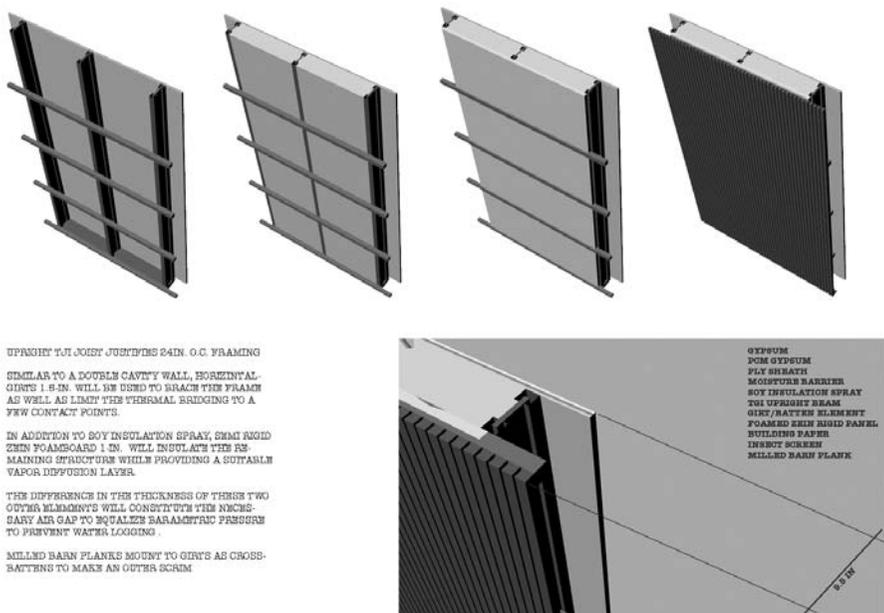


Figure 9: Different wall sections considered for the house envelope (Eric Smith 2008)

4.3. THE PASSAGE CROSSING: DETAILING JOINTS

Energy efficient detailing included the reduction of thermal breaks. The wall structure for the house was designed in two layers so that only minimal thermal bridging could occur. The team collaborated with material researchers (Grewell, Jarboe et al) in a search for new insulation materials with low thermal conductivity through foamed bio-based composite materials for thermal performance and environmental stewardship. Additionally it was important for the team to utilize the double function of materials, so that they perform usability functions as well as tasks for human thermal comfort like thermal mass in countertops, pebbles and floor boards. Finally the team worked with a door manufacturer to build doors with vacuum insulation for the North wall of the Interlock House with an R value of 40 so that a wall, which could be fully opened in mild seasons, could also act as a thermal resistant barrier in the cold of the Iowa winter.

5. FRAME: ATMOSPHERE – TYPOLOGY

5.1 ATMOSPHERE

The open plan can act as a design and functional strategy for thermal flows in appropriate seasons. The atmospheric quality of space is defined by physical quantities: plenty or lack of oxygen, and constantly changing humidity, heat, wind, pressure or tension (Table 1). The perception of space though deals with the atmospheric qualities. A space with a draft is regarded as not comfortable in connection with a prescribed use, like working or doing any sort of physical activity, but a breeze nevertheless can make natural ventilation possible and can be very pleasant.

Environmental characteristics have a huge impact on the development of spatial language, symbols and icons as culture is manifested through atmospheric and climatic properties. Humidity, dryness, heat, cold and light intensity have left their mark in the built form, roof type, surfaces, and openings of buildings. Buildings position themselves in relationship to the direction of the sun, the prevailing winds, etc. The need for vision, light, heating and cooling is based on the interrelation between the climate outside and internal needs. The porch as a spatial device met all of those needs (Fig. 10).

The overarching goal is to reduce energy consumption and to increase spatial delight by design. For this to occur, spaces above and below need to be interlocked and intertwined so that the air can move about freely (Passe 2009).

5.2 TYPOLOGY

‘Typology of use’, ‘typology of space’, ‘typology of structure’ are common terms in the discussion of architectural forms. There is a long discussion in architectural history and theory on the meaning and relevance of the term type and typology (Passe 2007). Reyner Banham (Banham 1969) very clearly points out that architectural type also forms the relationship to the external climate: the massive block or the tent-like structure not only engage differently with materials (brick walls versus light structure) but also imply a different use of space: the fixed and the loose boundary (Fig. 11). This house was designed to change its boundary with the seasons and solar radiation.

Common patterns relate to spatial types with a strong impact to climate and spatial ventilation, which is obvious in the typology of the dogtrot house of the American South, which for part of the year also functions in Iowa. The open plan typology used for the Interlock House fulfills various purposes. The Sun Porch (Fig. 6/10) is a semi-private indoor and/or outdoor space with a southern exposure that creates a warm microclimate. The north side of the house has a cooler microclimate, providing respite from summer heat and creating a more public, sociable space where inhabitants can interact with surrounding residents, enabling front-porch living.

The north entry doors are vacuum insulated for maximum efficiency during cold months. In the winter, only one of the four doors is likely to be used or the inhabitants might come and go exclusively through the Sun Porch, leaving snow boots and heavy coats to drip and dry in a space that functions as an airlock. The Sun Porch is enclosed on three sides by two different movable glass wall systems. When the exterior wall is fully open, the porch is open to the deck and garden. In the summer, the Sun Porch can serve as a shaded outdoor room. In a recent HB 2009 paper (Author 2009) the CFD

Scale Number	Speed (mph)	Description
0	0	Calm; Smoke rises vertically
1	1–3	Wind motion visible in smoke
2	4–7	Wind felt on exposed skin; Leaves rustle
3	8–12	Leaves and smaller twigs in constant motion

Table 2: Ventilation figures (Engineering team 2009)

Room	South (mph)	North (mph)	South (Beaufort)	North (Beaufort)
Kitchen	0.79	0.17	-1	-0
Hall	0.06	0.05	-0	-0
Bed/Bath Rooms	0.77	0.17	-1	-0
Whole House	0.14	0.09	-0	-0

Table 3: Current Design Results—Minimum Required Wind Speeds for 10ac/h (Values recalculated May 26, 2009)

scale. Ideally, the wind speed necessary to have ten air changes per hour in a given room would be less than a three on the scale, with the lowest number being the most desirable. The average summer wind speed for both Iowa and Washington, D.C., falls in the three Beaufort scale range. Average wind directions for both locations are generally from south to north. The north-south orientation of the house lends itself easily to natural cross ventilation.

According to the calculations in Table 2 and Table 3, even the slightest breezes will effectively cool the house. This is largely due to the sizable openings of the operable windows. This means that on days that actually have a breeze above a one on the Beaufort scale, only a few windows need to be opened for effective natural ventilation.

The mentioned recent HB 2009 paper (Passe 2009) presents similar temperature patterns for the Viipuri library. The ventilation system for the Interlock House was designed with this knowledge in mind.

The views demonstrate a reduction in temperature with increasing velocity within the library's large reading space as the room cools due to airflow through the entrance. The vertically connected spaces cooled significantly faster than adjacent spaces. While general patterns can be retrieved from those two simulations, due to the complexity of the spaces and their parameters, predictions can only be made for individual spaces and involve elaborate modeling skills and knowledge of weather patterns. The novelty in the three-dimensional approach presented ... is the combination of thermal distribution and air velocity, and the possibility to evaluate them in a three-dimensional composition.

(Passe 2009)

5. FRAME: TECHNOLOGY – DESIRE

In Hermes V Serres introduced Zenon who walks the coast and never reaches his destination because at increased level of scale, the boundary becomes longer and longer. A wall divides and connects, acting simultaneously as boundary and threshold.

6.1 TECHNOLOGY

Prior to the development of mechanical air-conditioning, vernacular architecture used passive-building integrated strategies of spatial composition, ventilation heat retention and thermal storage

as an integral part of their cooling concept. House typologies like the bungalow adapted for Iowa in the late 19th century integrated colonial experience from British India with building technologies developed in New England using shade, material properties and natural ventilation. One main feature in this spatial strategy was the porch, a transient space, which acted as a main social gathering space, a shading device in summer and a sunspace in winter increasing seasonal comfort. Since the development of mechanical air conditioning in the U.S. building industry of the 1950's (Ackermann 2002), devices for heating and cooling have been separated from the design process and the porch as a climate device has disappeared from new residential neighborhoods, only images remain.

The ISU team investigated the potential of the porch for passive cooling strategies for the Iowan climate in its various forms through Ecotect analysis and with a variety of enclosures to develop intrinsic transient spaces for energy efficient and culturally rooted sustainable residential buildings in Iowa. The design team investigated vernacular strategies and combined them with contemporary passive means of thermal mass storage for night cooling. The aim was to maximize their potential as a conceptual cooling device and integrate them with innovative active mechanical ways of cooling through desiccant dehumidification.

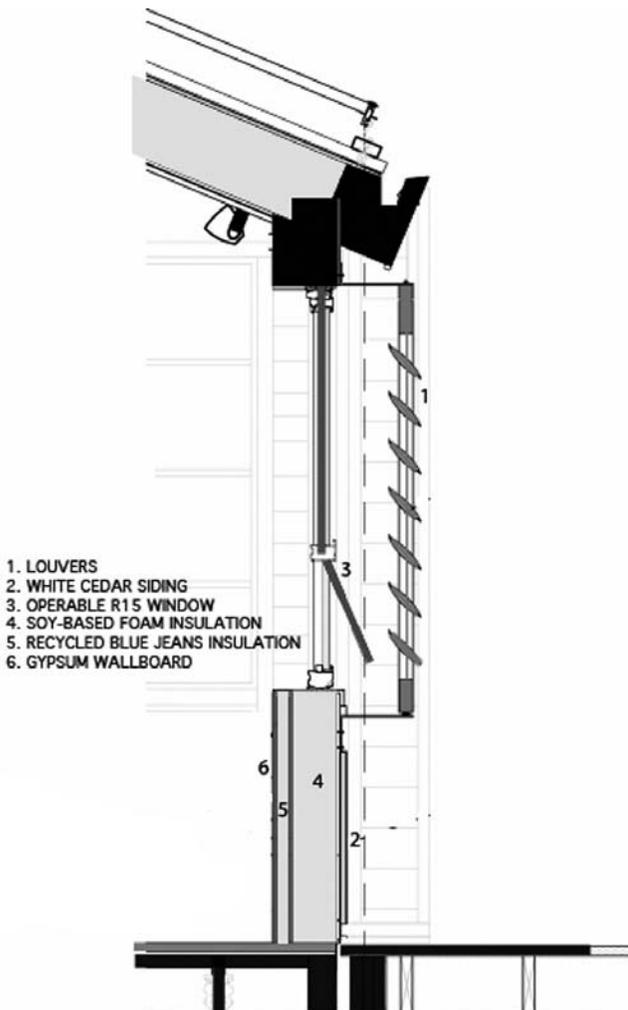


Figure 11: Wall section with high R-value (Team 2009)

The porch / sun space was designed as a climate device (Fig. 5, 6 + 10). The spatial composition of the Interlock House is seasonal. The Hall and Sun Porch can be reconfigured and opened to the elements. The Sun Porch, with added thermal mass in the floor, mediates light and heat and encourages convective loops to heat and cool the house. A louver system spanning the south façade also mediates light and heat and reduces the active cooling load in summer months. The louvers allow occupants to manipulate light and heat according to activities and privacy needs. The house requires active manipulation of its doors, windows, and exterior louvers to influence airflow and to maximize or minimize heat gain and loss. This reliance on several basic passive solar and ventilation techniques helps reduce the energy demands for the active systems. The effective meshing of the active and passive systems needs an alert and motivated resident. The long-term goal is to *integrate* the effects of passive design strategies into the energy performance evaluation of mechanical HVAC equipment for residential buildings in Iowa and equivalent climates, thus reducing energy requirements of mechanical (HVAC) systems.

6.2. DESIRE

The Interlock House was designed as a home and not as a machine, because there is still a desire for well-temperedness, for feeling and touch, the smell of nature in addition to application of energy-efficient technology. The passive strategies of the house were designed with an active user in mind engaging the occupants and their desire of personal control.

The Interlock House's lighting strategy is layered and hierarchical in order to enhance the aesthetic experience and functional needs of occupants and to address comfort and safety. Special attention is given to the role of light and color surfaces in supporting normative changes in vision that occur with aging.

Keeping Universal Design principles in mind, depth perception is enhanced by selecting colors that sharpen edge contrast. Through the selection of non-shiny surfaces, and the use of adjustable louvers to diffuse daylight, the Interlock House is able to increase the level of illumination needed, without increasing glare.

6.3. THE PASSAGE CROSSING: DAYLIGHTING

The Interlock House lighting strategy begins by optimizing daylight and minimizing the need for artificial illumination through the use of windows on the south, east and west sides of the house and high north clerestories (Fig. 12-15). Large windows on the south side and Sun Porch allow a maximum amount of daylight into the house, while built-in movable louvers adjust the quality and quantity of light as needs and activities change across the day and season. A sunny summer breakfast is even more delightful when warmth, brightness and glare can be modified by simply sliding a louvered panel that diffuses light without blocking it out.

Light levels throughout the house were considered. Conditions were studied for October 12th 2009; the sun angles are specific to that date and the longitude and latitude locate the structure towards the eastern end of the National Mall in Washington, D.C. The period of time studied—from 6:00 a.m. until 5:30 p.m.—includes sunrise and sunset. The team studied three atmospheric conditions—clear skies, partly cloudy and overcast conditions—as they each yield very different lighting effects.

7. CONCLUSION: THE ICE BRAKES

The Northwest Passage, Hermes and Zenon act as metaphors in Michel Serres critique of the current divide between the humanities and science. I have used the same metaphors to show how the divide between engineering and architecture can be overcome with a novel team design approach. The conceptual outline of a mind map as organizational structures for design teams will remain a task for further research into project based team strategies, but it can already be stated from experience, that without a changed decision structure in the design team, true sustainability, where aspects of humanity are addressed interwoven with aspects of science will not be achieved. The design practice

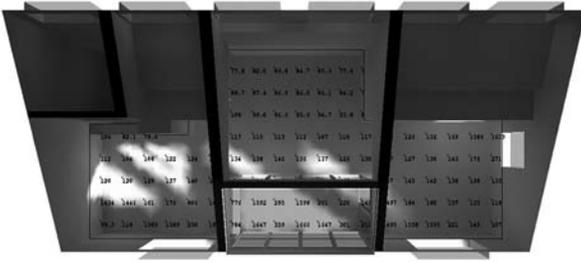


Figure 12: Clear sky 8.30 am. (J. George 2008)



Figure 13: Clear sky 10.30 am. (J. George 2008)



Figure 14: Partially cloudy 8.30 am. (J. George 2008)



Figure 15: Actual interior 10.30 am. (U. Passe 2009)

of the architect's profession, such as spatial layout to create social places related to topography, sun orientation and climate through its composition and beauty need to be part of standard engineering approaches as well as measured performance needs to become part of standard design evaluations. The need was revealed in the four narrated passages of proportion, detailing, ventilation and daylight, where the team jointly managed to reach the outlet of the passage.

ACKNOWLEDGEMENT

As indicated, the Interlock House was a team project and would not have been possible, with the effort of all. The website <http://www.solard.iastate.edu> lists all team members and financial sponsors. As lead faculty PI I am indebted to all my colleagues and students who contributed their expertise and time to the project.

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Humanization and Architecture in Contemporary Hospital Building

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ABSTRACT:

Architecture and health are closely dependent. Architecture more positively influences human health as appropriating to its needs. However, humanization of hospital spaces wasn't always evident. Since the end of Second World War, in fact, the hospitals are good buildings if they meet only the technological and functional requirements.

Dealing with humanization and its architectural quality means to focus the human needs and understand their interaction with the environment. In these terms, it is not easy to define the architectural quality, because it is based on principles, which in turn are not quantifiable. Although, there are several studies from different disciplines which allow choices in terms of "added value that can be achieved".

In this paper, we propose the results of a research about this issue. Focusing on the psychological need of man, treasuring contributions of these disciplines (particularly about environmental psychology, expressive arts, Ergonomics, Evidence-based Design, the art of gardening, the studies on the perception of shape and color) and analyzing the functional and formal features of contemporary hospital, we developed a system evaluating architectural design choices, and a methodology defining guidelines to direct the choices aimed at the humanization of hospital space.

Conference theme: On Approaches

Keywords: hospitals, humanization, architectural quality

INTRODUCTION

Many scientific patient-centered researches have shown, as the psychological distress which inevitably follows the sickness can be contrasted with an environment able to support patients' psychological needs (Ulrich 1991, McKahan 1993, Lemprecht 1996). Patient psychological well-being depends on many factors, such as, for example, light, exterior views, art, accessibility to gardens, etc. The architectural design has to take into account these considerations in order to build an environment where the patient will be able to live without anxiety.

In the years immediately following the Second World War the hospital construction has answered, essentially, only to functional and technological requirements. It was an efficient *machine à guérir* (Foucault 1979), "the perfect architectural expression in the age of high-tech medicine" (Verdeber 2000,13).

In the late 50s, the Modernist counter-culture, as reaction to this point of view and under the influence of the studies of the psychologist Abraham Maslow (1968) on *Hierarchy of Needs*, begins to talk about humanization regarding the care, the healthcare institutions and the user needs. Since then many initiatives, including for example the "Hospice movement" (1967), have developed their activity on the issue of the humanization of healthcare. In the last twenty years, the hospital humanization has focused also on architectural and design aspects. Nowadays to guide the designers' choices in such sense, there are only just indications with general and approximate character. The main problem in order to formulate a system of guidelines is due to the same nature of the concept of humanization, based on the psychological well-being, often not quantifiable. In fact, different disciplines: Environmental Psychology, Architectural Psychology, Neuroscience, Immunoneuropsychology, Ergonomics, Evidence-based Design, Theories about Perception, contribute to define the concept of humanization and then contribute to the definition of the quality of contemporary hospitals, that is related also to the humanization of hospital spaces and therefore to the quality of contemporary hospital buildings. Each of these disciplines aims at achieving the architectural quality and improving

users' well-being, because the beneficial effects derived from their application but are not easily quantifiable.

The work presented is part of a more general research, *Hospital space: design guidelines and trends*, whose purposes are: 1) the comprehension of the formal identity of contemporary hospitals and the expectation about their possible future development; 2) the definition of an assessment methodology of architectural design choices, and 3) the development of a system of guidelines able to direct the project from the point of view of the humanization of spaces supporting the healthcare activity.

Omitting the first part, the other points were already carried out in a previous work, (Pellitteri, Belvedere 2010) of which this is a further consistent development.

I. METHODOLOGY OF ANALYSIS AND ASSESSMENT OF THE CHARACTERIZING SPACES FOR THE HUMANIZATION

The spaces serving hospital not only communicate and represent their health content, but they also provide stimuli affecting the user psychological well-being, satisfying his needs of humanization. These spaces are: entrance hall, corridors, rest and waiting areas, patient rooms and day rooms. In these areas often more representative and characterizing than others of the architectural quality of building, users can “save/affirm the identity of their own personal and social existence” (Spinelli et al. 1994). The methodology assessing the quality of architectural space in terms of humanization, derives from the study of the environmental system (UNI 10838:1999, Italian standard) based on its needs, requirements and performances. Respectively about these we deal mainly with:

- Need: What it is required for the correct carrying out of user activity;
- Requirement: Identification of factors and conditions that can satisfy the need;
- Performance: Behavior of the space considered.

The requirements, that we have considered, are the psychological ones.

The main activities performed have been identified for each characterizing area for humanization. The main psychological needs of patient based on the Hierarchy of users needs (Jordan 1998), are: Recognition, Acceptability, Usability, Territoriality and Amenity (Table 1).

Herein there are indicated some performances (Table 2) referred only to the **entrance hall** (of course, in theresearch, all the performances were defined related to each space). Among all the mentioned areas, the entrancehall is the most important for the humanization. It is not only a simple instrument to enter into the hospital building, itis not a static barrier, it is a dynamic threshold between the interior and exterior space, “making gradual and not brusque the detachment from the everyday existential dimension” (Pellitteri 2008).

NEED	REQUIREMENT	DEFINITION
Recognition	Visibility	Ability to detect and identify an area on basis of physical and context characteristics.
	Representativeness	Ability to communicate the function in an unequivocal way.
	Spatiality	Own qualities (shape, distribution and physical disposition of the environments) of the built environment.
Acceptability	Comfort	Environment ability to convey a sense of well-being, eliminating or reducing the unpleasant o inconvenience sensations.
	Variety	Presence inside an environment of multiple and different elements.
Usability	Continuity	Ability to maintain the relationships that link together two separate and distinct pieces/areas of the building and of these between them.
	Orientation	Ability to transmit information that activates cognitive functions. It can be <i>guided</i> and <i>spontaneous</i> .
Territoriality	Privacy	Ability of a space to protect the personal and private sphere.
	Socialization	Ability of a space to improve interpersonal communication.
	Familiarization	Ability of a space to have features more similar to house/urban appearance.
Amenity	Sensory	Ability of an environment to stimulate the sensory perception.
	Unity	Expression of the formal and functional relations of each part of the building and of them together.

Table 1: Requirements corresponding to such classes of needs with the related definitions.

REQUIREMENT	PERFORMANCE
Comfort	Presence of exterior views According to Psychology, it meets the needs of man establishing continuity with a point located outside of themselves and of his sickness.
Sensory	Prevalence and chromatic agreement It has been demonstrated by Immunoneuropsychology studies (Gappell 1992, Solomon 1996) that the color, beyond being an important communication element, full of expressive and symbolic contents, affects also emotions and human physiology: red stimulates the sympathetic nervous system and the brain wave activity, and accelerates heart rate, increases blood pressure and respiration; blue triggers the parasympathetic nervous system, and is credited with a tranquilizing effect. Color, according to the Gestalt Theory, influences the perception: the warm colors (red, orange, yellow) seem moving forward, cold ones (green, blue and purple) appear receding. The use of cold colors make lighter and smaller objects, while the rooms seem bigger, etc.
Spatiality	Shape "Theory of good form" (Gestalt Theory) says that the structure more easily recognizable is the simplest one, that in which the obviousness of the intended use is associated with clarity and essentiality of the volume and the spatial distribution.
Privacy	Distance among sittings The same distances, indicating the intimate, personal and social relationships between people, (Theory of Proxemics, Edward T. Hall 1963) are used to indicate the right distance among sittings.

Table 2: Some performances related to the entrance hall.

Needs, requirements and performances, specified for each area, are inserted into a form (Fig. 1 and Fig. 2). For each spatial unit, the needs, requirements and performance with the related conditions for their implementation are inserted into a report. An assessment parameter is assigned to each condition of implementation of the performances, that expresses the presence/absence of the environmental requirements requested, that is the perfect matching of the requirements for implementation to the requirement (value equal to one) or, if the value is null, the opposite. It is also an intermediate value, 0.5, where the performance does not fully meet the requirement. They express, in quantitative terms, the value of environmental quality aimed at humanization.

So for each spatial unit there have been obtained indexes that express in numerical terms, the value of environmental quality aimed at the humanization.

2. CASE STUDIES

The case studies represent a range of different design experiences, hospitals built in the last ten years in industrialized countries. In these buildings the designers have demonstrated attention to the definition of design solutions oriented to the humanization of space.

The analysis form of each case study is organized into three parts. In the first part of the form, there are general information about the history of building, the location and the relationship with the place, the materials characterizing the exterior surfaces, the utilization of non-traditional building technology and the presence of qualitative elements such as gardens, art installations or places for spirituality.

The second part of the form, on the basis of reference tables, relates the assessment of characterizing areas for humanization (entrance hall, corridors, rest and waiting areas, patient rooms and day rooms).

In the third part, for each area, a brief comment has been drawn showing the points of strength, weaknesses and possible innovations.

Comparative assessment of the case studies highlights architectural trends, spatial potentiality and compositional variations, of such spaces.

The case studies are 32 (9 in Italy, 3 in Austria, 8 in Germany, 3 in France, 3 in Spain, 3 in United Kingdom and 2 in Turkey and 1 in Israel).

Entrance hall is mainly as a *Street* or a *Square*, but there is a substantial number of cases which can't be related to these "traditional" types. These are spaces having only the reception, the stairs and the lifts, the waiting areas and, sometimes a cafeteria. They are generic "hall". Few examples are hybrid, a crossbreeding between the *Street* type and the *Square* one.

11. Graz-West State Hospital
Graz, Austria.
1998-2002

Architektur Consult: Domenig Eisenköck Gruber



HOSPITAL SPACE: TRENDS AND DESIGN GUIDELINES

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Figure 1: Part of the form about Graz-West State Hospital (Austria).

AREA	NEED	REQUIREMENT	PERFORMANCE	VALUE		
ENTRANCE HALL	ACCEPTABILITY	Comfort	Presence of a reception	Visible from the entrance	1	
				Not visible from the entrance	0,5	
				Characterization of the point of reception	Yes	1
					No	0,5
				Position of the point of reception respect to the entrance	Central	1
					Lateral	0,5
				Position of the point of reception respect to the paths	Central	1
					Lateral	0,5
				Presence of rest areas	All visible	1
					All not visible	0,5
				Presence of artistic installations / paintings / sculptures	Well visible	1
					Not much visible or not in the best visible	0,5
				Presence of plants	Well visible	1
					Not much visible or not in the best visible	0,5
				Presence of aquariums / fountains	Well visible	1
					Not much visible or not in the best visible	0,5
				Presence of coffee/snacks/beverages dispensers	Well visible	1
					Not much visible or not in the best visible	0,5
				Presence of natural lateral lighting	Zenithal and lateral	1
					Only zenithal or lateral	0,5
	Source of the natural lateral lighting	From north	0			
		From south	1			
		They don't impede the visual continuity between interior and exterior	1			
	Presence of control systems of the natural light	They impede the visual continuity between interior and exterior or are not present	0			
		Can green, on areas of historical/architectonic interest, an internal courtyard with garden	1			
	Presence of views on the exterior	On the internal courtyard garden without garden	0,5			
		On the parking or urban areas, an areas of modest architectural/environmental value environment.	0			

The full-height entrance hall with the gallery and the red blood sculptures.



GRAZ-WEST STATE HOSPITAL

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Figure 2: Part of the form about Graz-West State Hospital (Austria).

A strong element, recurrent, in the latest architectural expression, is that of a large open route, which from the entrance crosses the entire complex, both horizontally and vertically. It is a place of enormous connection, not only functional, among the most used areas (both in care and in non-hospital services offered), but also perceptual. It's the "hospital Street" that, in particular morphological situations, can become a *Square*, like for example at Kentish Town Health Centre (London). A place that is the connective tissue of hospital pathways and spaces, a space that is also a "gallery" inside the hospital, continuously projected toward the urban space and the external environment. "The street as a figure", according to Arnheim (1981), where the traveler's eye directs the route supported by his experience of urban space and guided by the *impression* of the road that is "a sense of easy access, clear direction, boundaries defined to advance with confidence". Entrance hall is the site of the initial impact with the hospital, the interface between the healthcare facility and the user, the communications center and the junction of crossing flows. The morphology of the environment is particularly important. It can facilitate the identification of the main directions. The unitary language of the architectural elements and furnishings is important too. The presence of numerous and different activities, hospital and non, are representative of the accepting will of the hospital, respecting patient different needs and proposing an usage, not only hospital, of its spaces. So the building opens itself also to the territory and the social context where it resides. The double-height entrance hall of the Provincial Hospital of Graz (Austria), for example, is conceived as an exhibition space with minimalist furniture, works of graphic art and the work of Hans Kuperlwieser, a permanent installation of red blood sculptures that evoke the shape of human organs. Always in Austria, the entrance hall of the Hospital Center in Anichstraße, Innsbruck (Fig. 3) is a real public living room, with comfortable sofas, soft lighting and a nice garden view, here people can take a break and talk friendly.

A functional conception still different, influenced by that of the “mall”, is that which indicates the entrance hall as the ideal forum for businesses. So, for example, the double-height hall of Agatharied Hospital (Germany) is dominated by a *promenade* that connects the ground floor to commercial activities at the first level. A magnificent example of entrance hall is the large covered one, enriched with luxuriant vegetation, in the new Mestre Hospital. This is thought to be a large garden square with reception, bar, restaurant, shopping areas, offices for the public, religious services and offices for the associations. On its façade, on the upper floors: the outpatient department, the day hospital, medical offices and wards.

Entrance hall in pediatric hospitals are even more daring. In the entrance hall of the Pediatric Clinic of Aschau (Germany), for playful and also therapeutic use, it has been prepared a climbing wall, 15 meters high and 4 wide. The entrance hall of Royal Alexandra Children’s Hospital (Brighton, UK), offers a continuous sequence of fantastic and colored places that reproduce the different natural habitats with their animals. The ‘bioclimatic greenhouse’, of the Meyer Children’s Hospital (Fig. 4) in Florence is a laminated wooden structure, it is like a fairy forest. Within a very bright environment the “kiosks” for information and acceptance are located near the waiting areas, whose colorful character is part of a larger artistic project. In this art project, coordinated by the designer Andrea Rauch, every single interior is designed as part of an imaginary tale: the *artistic glass*, separating the giant waiting room from the service corridors, gives stylized natural forms; the *zodiac* is made up of a group of metallic installations suspended; the *clouds in the sky* are a group of paintings placed along the walkways connected and under a large skylight; the *light cones* are two great spinners coated ceramic glazed in bright colors; the *fantastic fishes*, the *multimedia installation*, the *sails as curtains*, the *care toys*.

Although the hospital is a building complex, also for the distribution, the user should be able to perceive it as simple and cross it instinctively, without being confused. So the presence of a system of wayfinding assumes a fundamental role, contributing to the construction of mental maps. For example, in the Circolo Hospital and Macchi Foundation in Varese, a sequence of color was adopted for different floors. It is based on the balance principle of the ‘harmony of the four colors’ by Jorrit Tornquist, international artist. Four different pastel colors are alternated, with a modulation exponential of brightness, from lower floors (dark) to the highest (unclear). Where the transition is fast, colors are more saturated, while in the living areas the colors are de-saturated. In a wayfinding system are important: the visual, acoustic and tactile signs and also the lighting and the shape and distribution of the ways. In fact, these are often sewing up among different parts, instead of an organic and contextual operation of the whole building. Sensitive points in the design of the routes are: landings of stairs and lifts, which must be clearly identifiable, and the waiting areas, presence and location, which need not to be an obstacle for either visual or walk.

Corridor, as the same word of Latin origin means, is a fast link where the soldiers, under siege, ran between the towers of the fortification. The corridors of modern hospitals, unfortunately, give the same sense of danger, siege and anxiety, trying in vain and for a long time to look for a never seen destination that seems unattainable. The feeling of futility of the elapsed time is associated with those of the isolation and the rejection, the inaccessibility of space and the unknown (Pellitteri 2008). Corridors of cases studied show that, despite the lengths shorter and less tortuous paths, are still



Figure 3: Hospital Center in Anichstraße (Innsbruck, Austria) - entrance hall, corridor, patient room (Nickl-Weller 2007).

monotonous and anonymous. In addition to the aforementioned system of *wayfinding*, some design choices work positively for the perception of their spatial and functional property: the proportions of the cross section, the length, the views toward the exterior, and views of interior spaces placed at multiple heights, the integration between natural and artificial light and the color of the walls and the flooring. Color is not just essential for guidance, but also, according to the studies of *Biological Perceptibility* (Bertagna 2008), it is crucial for correct perception and space usage. Man has the psychological need to walk on a “solid basis”, dark colors, recalling those of “ground” (brown, yellow and red), are recommended.

Even the waiting areas, such as the journeys, are not always designed together to the building functional articulation. They are often made out of residual space. They are peripheral to the area to which you have to access and don't show any element (an exterior view, an art object, the composition of plants, etc.) drawing attention to the user, detaching him from his stressful waiting.

Outlining the requirements and performances of waiting areas, it is necessary to distinguish different types of ‘waiting’, because different ways of using and different psychological needs correspond to each of them. Waiting areas of the outpatient hospitals are characterized by a high state of anxiety and emotional tension and a perception of dilated time. In the atrium the waiting support to other functions, have a considerable degree of representativeness and there is a greater tendency toward socialization, among users and users/operators. The waiting areas in the corridors, punctiform through the building, have the force of disruption and characterization of pathways and they are an extension of functional areas more defined. Among the cases investigated are reported some German examples. The waiting area in the outpatient clinic of Radiotherapy in the Hospital Center Ostalb Aalen, has a courtyard garden and also a large aquarium participating at the space composition. The rest area in the entrance hall of Children's and Gynecology Hospital Carl Gustav Carus in Dresden is a wide area extended along the entrance hall opening into the garden with a terrace. The rest area, set along the path connecting outside with the central covered atrium in Albklink Hospital, proposes in the size and furniture the intimacy of a domestic living room.

Together with the entrance hall another area subject of special attention is the patient room. There are more avant-gardes examples in profit health system. These rooms, using the studies of Evidence Based Design, have hotel-like characteristics. They improve patients' quality of life. Inside the room a semi-private area is foreseen. This is a living that allows more and better interaction between the patient and the family members who assist him, ensuring a greater sense of ‘territoriality’, too. From the room the patient can see outside. In temperate zones, the rooms are also equipped with a solarium, to enjoy the therapeutic effects, including psychological, of the sun. The furniture, taking care to the tactile and visual characteristic, allows customizing the environment by patients. However, medical instruments and equipment technology tend to be camouflaged, almost hidden. Patients may act independently on the systems of lighting/dimming and on those for the temperature control in the room. Two particularly significant examples of the trend that wants the patient room similar to hotel ones, are the patient rooms in the Evelina Children's Hospital (London, UK) and in the Angel's Hospital in Mestre (Venice, Italy). Both have no hospital furniture-type, the medical equipment is hidden, and patients can look out of the room and onto the atrium, or can close dimming systems, resulting in privacy. These rooms are open and permeable areas within the hospital building, they aren't areas of segregation.



Figure 4: Meyer Pediatric Hospital (Florence, Italy): entrance hall, waiting area, corridor (Belvedere 2010).

A space where the project is not careful as in the patient rooms is the day room. Indeed, not all the hospitals surveyed are provided of it. Probably, this is because the patients' rooms, even when they are not hotel-like, have within living/sitting areas, used by the occupants to receive visitors or to socialize with each other.

3. GUIDELINES FOR HUMANIZATION

We have defined the guidelines providing the designers' choices for the humanization (there are not contemplated others design aspects) of each area above mentioned, from the analysis and evaluation of the case studies and the actual theoretical studies. They are aimed at the architectural design of new hospitals, even if they can be applied to existing buildings and some of them might not always be coherent with the culture and any specific local need.

For each requirement, if not for each area, the arguments related to the individual elements constituting the space (paths, architectural elements, signs, etc.) are highlighted. Also the relations that the spaces have with the outside of the building and with other related parties orientation; size; organization and distribution; lighting and perceptual aspects related to the shape, the color, the materials, the finishes are highlighted.

Regarding the need of **Recognition**, the guidelines of the **Entrance Hall** are reported for example (Table 3 and Table 4).

NEED	REQUIREMENT	GUIDELINE
Recognition	Visibility	The paths, also from the parking area to the entrance hall must be clear and legible: <ul style="list-style-type: none"> - those vehicular must be distinguished from the pedestrian ones; - both vertical and horizontal signs must be present; - if longer than 50 meters, they must include a waiting area clearly identifiable; - must be adequately lighted.
		The outdoor areas, if available, should be used as garden and provide parking at no more than 50 meters from the entrance.
		Parking: <ul style="list-style-type: none"> - in small hospital building (no more than 500 beds) can be buried, thus allocating superficial areas as garden.
		Architectural elements (canopies, overhangs, recesses, arcades, etc.) can be placed on the façade, showing the location of the entrance. They must be distinguished in shape, color, materials and finishing. <ul style="list-style-type: none"> - colors must be complementary or otherwise contrary; they must not be of the same tone; - if the materials are the same, finish / texture must be different.
		Entrance must be lighted to be visible at night.
		The shape of the building must be lighted to be seen easily in the urban/territorial area.
		The luminous must be clearly visible from a distance: <ul style="list-style-type: none"> - color is different, preferably in contrast with background; - position must be predominant, with no visual obstacle, and lighting the entrance; - dimensions must be related to those of the building.

Table 3: Guidelines of the Entrance hall.

NEED	REQUIREMENT	GUIDELINE
Recognition	Representativeness	Position of the entrance hall must be the gravity center of the building complex, otherwise it must be the focus of streams and paths and related and connecting with the different areas and functions of the building.
		Architectonic elements and furniture, like information desk, sculptures, columns, etc.: <ul style="list-style-type: none"> - can be placed on a side and/or centrally in the entrance hall; - can be placed on a side, not interfering with the path, if the entrance hall is mainly longitudinal (<i>Street or Gallery</i>) - can be placed in the center if it is not a visual obstacle; - must harmonize in color and material with the context; - can be accentuated or damped cooperating in relation to all the environment; - It is advised against monochrome and monomateriality.
		Materials of floors, retaining some of the exterior characters and preparing to introduce to the interior spaces, must be different from both the interior and the exterior ones.
		Brightness must be different in singular areas/spaces: <ul style="list-style-type: none"> - waiting areas must be lighted differently than path; - lift landings must be lighted differently than entrances to services.
		Artificial light must complement the natural one. It must be dosed related to the specific area, to the type of activity and number of people that are inside.
	Spatiality	Entrance must not be directed near the North.
		Organization of areas and services with their main and secondary vertical and horizontal systems must be simple, obvious and clearly distinguishable.
		Geometry of the entrance hall must be clear and ascribable to primary geometric forms. In small hospital building (no more than 500 beds): <ul style="list-style-type: none"> - <i>Street or Gallery</i> type, which primary form is a rectangle, should have width not less than 5 meters and length from 50 and 80 meters; - <i>Square</i> type should be 30 meters in length; - "Covered patio" type should have a length no more than 15 m.
		Section must be rich and varied, showing changes in the shape of coverage, especially in correspondence to the different space usage. If the height is constant, it is recommended that the height is not equal to or less than the width, because the space is perceived as oppressive (in the <i>Square</i>) or monotonous (in the <i>Street</i>).
		Natural light must be filtered by control systems that must not impede the visual continuity between inside and outside.

Table 4: Guidelines of the Entrance hall.

4. CONCLUSIONS

The methodology of analysis and assessment elaborated is here presented in order to verify if hospital spaces are designed for their humanization. From the case studies we have seen that the goal of humanizing hospital spaces sometimes is centered. Many times it remains a designer's intention because functional requirements or economical purposes prevail over humanization needs. When designers are free to take into account also this fundamental aspect, we can find architectures qualitatively acceptable. Humanization improves spatial and therapeutic features, so it improves architecture. Then, our research wants to define an approach to design not based on a "good practice" but on a scientific methodology, aimed to write specific guidelines for humanizing hospital spaces. Guidelines are a way of suggesting a system of criteria for designing new spaces or to adequate the existent ones. Certainly, they have to be verified experimentally with a really project and they are susceptible to further careful examination.

However we can highlight some critical aspects. First, the field of research isn't limited to the areas that we have considered. In fact, there are many hospital spaces like outpatients' departments, day hospitals, diagnostic areas that are very important, too. In these areas the medical aspects often exceed the human one. In recovery rooms and intensive care unit the contrast between the technological sophistication of modern medicine and the incapacity to consider adequately the human needs is the most evident. The patient, even if "passive", is very sensitive to the environmental quality around him. Other areas external to hospital have an important therapeutic role, i.e. the healing garden, and they are important for the relations between the building hospital and the urban and landscape context. Another field of study concerns the user. Our research actually considers only the patient, but in the future we might consider the staff, too. Consequently, we'll study another side of humanization, related to workplaces.

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Quality in Architecture - A Disputed Concept

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ABSTRACT:

The overall aim of this article is to clarify the concept of quality in architecture and urban design. Quality in design is connected to a set of values. The fact that the perception of quality connotes values, varies with time and is different among individuals does not free professional judges from taking a stand on essential quality questions. Therefore quality in architecture and urban design appears to be a fundamentally arguable concept that is subject to a wide range of interpretations. The hypothesis is that quality in architecture and urban design should be understood as an open and debatable key concept resulting in disagreement and discussion. New cases of quality arise continuously. The concept itself is value-laden and quality is interpreted with support of value charged criteria. Quality is something positive which meets with public approval. This type of knowledge is obtained by having good examples and interesting cases pointed out. The target is high quality. A special historical understanding is needed to reach this goal. The concept of quality even reflects the holistic approach of the architectural profession to design projects. The built environment is of public interest. Thus there are different interpretations of the meaning of the concept quality, its scope and status.

CONFERENCE THEME: On Approaches, The role and use of philosophy in architectural research.

KEYWORDS: Architectural quality, Architecture, Design, Judgment, Essentially contested concept.

INTRODUCTION

“Objective elements shouldn’t be relied on initially. Instead ‘go for quality first’ he said and meant that quality judgments were preferable” (Hemlin et al, 1990, p 59). That statement made by an expert when appointing a professor of architecture hits the nail on the head: what is quality in architecture and urban design? What do architects mean when they talk about quality? How do they understand architectural quality?

In this paper I will discuss and clarify the concept of quality. The purpose is to demonstrate and explain how the questions of quality in architecture and urban design can be understood from a European point of view. Architecture is a field of knowledge embedded with values. Quality represents something good, a well-designed object. But what does it mean? The theory is that architectural quality as a key concept is basically disputable; this shows up in the design and appraisal of architecture and urban design projects as well as when the built environment is evaluated.

The Swedish National Encyclopaedia gives several different examples of this concept. This can be used as a starting point. Quality can, firstly, be seen as a set of good attributes. Object O can be described as attractive: “O is of good quality”, “O has several good characteristics” or “O has a high and even quality”. Quality may also have negative implications: “O is of poor quality” or “O unfortunately has many shortcomings”. A comparison may reveal that object O 1 is worth more than object O 2. These examples have in common that quality is a concept related to evaluation that can be open or hidden in a message. Quality is a trait that either is good, bad or missing. In this case we want to be able to judge the worth of products and services.

Secondly, quality can be related to personal capacities, knowledge or inner characteristics of specific individuals. A person P may be described as being quality-conscious or well informed about quality questions. Examples of such descriptions are “P is an excellent artistic leader”, “P is a skilled architect with exceptional feelings for using concrete material” or “P is an exciting architect who has been winning several international design competitions.” Quality in this sense has an evaluation aspect. It is a sign of competence based on an ability to judge aesthetic dimensions. Good judgment in quality questions results in confidence.

Thirdly, quality can be understood as a specific relationship to a place. It is typical for architecture and urban design. In this case quality is attributed to projects that represent a whole and fit into a unique context. This perspective is found in architectural policy programs in Europe. The Danish Architecture policy, *A Nation of Architecture Denmark*, from 2007 is an illustrative example. According to the policy program, there is a "widespread agreement that architectural quality is experienced when form, function and building techniques are brought together and implemented in a complete, artistic idea. Architecture of a high quality relates to the surroundings as a co-player or as a challenger. The architecture stresses, strengthens and interprets the cultural character and uniqueness of the surroundings." (p 9) From this point of view, there are no general answers to architectural quality issues. Places always have unique characteristics. For this reason, quality must be design based on the understanding of the existing architectural qualities of the plot, surrounding buildings and the location.

Fourthly, quality can refer to a certain type of material or technological production of a product. Perhaps as a customer I want to know how the quality was determined, what material was used or which performances the technical solutions should meet. The answer from the salesperson, supplier and manufacturer could very well be "product P is a quality product which has received quality award Q". That means that P has been approved after testing according to a number of quality requirements. We get a quality concept that is specified with the help of measurable parameters. The point of departure is the idea of quality as something which can be assured by specific procedures; quality work, quality controls and quality management. Right quality is defined as zero defects. But it is not enough just to deliver the ordered products to generate a positive experience of quality. More is required if you want *good quality*. The design has to be connected to positive experiences and seen as valuable in the environment. Instead of looking for defects in products the design phase becomes a strategic phase in the production process.

The four statements link architectural quality to values, knowledge, places and quality assurance procedures. Quality is therefore understood from different perspectives. At the same time there is a common goal saying that architecture should be both enjoyed and suit its purpose. Since architecture has use as its goal it combines artistic ambitions and intentions with requirements for functions, method, material and economic solutions. The concept has both aesthetic and technical dimensions. The quality concept may be compared with soap in the bath water. When we try to establish what architectural quality is, clarity slips between our fingers. Good solutions to design problems are visible, can be experienced and can be pointed out. But they are very hard to grasp. There is something that escapes, is ambiguous, in the phenomenon and usage of the concept. Fault free and correctly dimensioned plans do not guarantee that a structure results in a positive quality experience. A well proofread manuscript free of typographical errors does not necessarily communicate an interesting message to the reader. Quality has to be more than zero defects. Absent friends do not promote good feelings. We need a generator. There must be an enhanced value for the object, an addition to the environment that communicates a feeling of quality to the user. This points back to the very heart of the concept of quality in architecture and urban design.

KEY IDEAS

This paper is about how we can understand quality as a key-concept in architecture and urban design in a fruitful way. The methods are "close" reading of documents (architectural policy programs, competition documents and referral opinions regarding changes in building legislation), conceptual analysis and re-use of interviews carried out 2005-2007. 18 experienced jury members, architects and urban planners, from Finland, Norway, Denmark and Sweden were interviewed in a Nordic study on contemporary architectural competition (Rönn, 2010). The theoretical framework for the investigation consists of Gallie's idea of "essentially contested concepts", which he published in 1956 in *The Proceedings of the Aristotelian Society* and in 1964 in the book *Philosophy and the Historical Understanding*. Gallie provides a tool for the analyses of quality and how this concept is used in the building sector.

My reason for re-using interviews and documents in the investigation is the belief that praxis reveals how professional practitioners speak, think and act in quality issues. In architectural and urban design quality concepts are communicated through drawings, sketches, illustrations, photomontages, plans, and descriptive texts. Quality is a dynamic concept, changing as new models are introduced, established and scrutinized. There are also many answers to the question of quality in architecture and urban design. But even if quality is difficult to grasp, there are a number of fundamental criteria from which to start. These criteria are about how design ideas are expressed and how they influence the public, users, clients or citizens. Architects and urban planners use criteria to identify, interpret experience, understand and judge signs of quality in the design field. Prize-winning architecture and urban design are all based on this assumption. The premises is that quality is a concept which can be judged in society; there are undertakings, structures and environments created to be attractive, arouse interest and be of value in some way.

Throughout Western history, starting with philosophers in ancient Greece, quality is perceived as a conflict between an objective and a subjective position; as a relationship between objects and how we perceive them through our senses. The objective position can be seen as speaking of qualities and means an impartial judgment devoid of self-interest. But that is not the same as saying that quality is found in the objects and their designs. The demand for objectivity only means that the quality assessment shall be based on facts and without bias. Objectivity in this case is an expression of honesty and the pursuit of truth on behalf of the judge. It should also be possible to control objective quality assessment in an acceptable way. But objectivity is not something that is either present or missing in an assessment; it is a scientific standard. It is a norm met to varying degrees when discussing quality in artistic undertakings, architectural works and designed environments.

A subjective position need not be problematic as long as the departure point is a personal meeting. Credibility in such quality assessments can be sought with the person who passes judgment and how it is justified. The subjective position is an aesthetic choice and is justified through learning and knowledge. The more educated the assessor is the more credibility is given to the subjective quality experiences. We trust the assessments of well-educated and experienced persons with good judgment. Quality as an experience requires an individual encounter with the undertakings and works; that a relationship is established which influences people. There are even some collective traits in people's quality experience related to their cultural backgrounds and professional practice.

Thus far linguistic usage doesn't present any great difficulties. Architectural quality is about distinguishing, describing, interpreting, understanding and explaining to the people around you what is good, better or poor in undertakings and structures. It sounds like a reasonable programme. The problem arises when we want to deepen the discussion in order to understand quality as a key-concept. Then the answer is no longer so obvious. To identify quality in product design, architecture and urban design in a meaningful way we need to choose a point of departure for the questions. Gallie offers a starting point for the discussion, a theoretical framework that gives meaning to quality conflicts in the building sector. We can learn about these differences by investigating how designers, architects and urban planners express quality. Which qualities can be demonstrated in artistic undertakings, architectural works and urban environments? How can the qualities in the environment be made accessible for credible assessments? To what extent may we trust quality evaluations? These crucial questions force us back to the starting point: how can quality be understood in architecture and urban design in a meaningful way?

AN ESSENTIALLY CONTESTED KEY CONCEPT

Architectural quality appears to be a basically contestable key concept with a wide range of interpretations in architecture and urban design. These thoughts were launched by Gallie (1956) and later by Janek (1991). Gallie was a British social theorist, political theorist and philosopher. He was a professor at three different universities. It was Gallie who first coined the expression "essentially contested concepts". This is a concept that leads to endless disputes about the correct meaning of the notion. Linguistic usage has both aggressive and defensive traits. Such is the case with debates about art, democracy and championship. Gallie uses championship as an enlightening example. In the world of sports, championship is considered to be something appreciated and valuable, a winning

concept. The concept changes meaning according to the circumstances. Championship is not only about being best on the field. A champion should also fight well and win the public's heart.

Gallie's description of an essentially contested concept fits quality well. In architecture and urban design, quality appears as a contested concept. The building sector is composed of professionals with different opinions about what quality is and how the concept should be understood. Architects use three types of rhetoric when describing quality: an offensive (aggressive) usage which attempts to create interpretation advantages. Architects usually claim they are best at designing and judging quality in architecture and the built environment. There is a defensive rhetoric. Architectural quality in society is seen as an overall intention, which the profession guards by means of general language. The defenders try to coordinate the different interested parties with a common ambition. High quality is the requirement. The rhetoric is also used to disarm potential opponents. This is the third type. Few would like to deny the need for a good built environment. It is the positive value implications in the concept that give quality its unifying function. Thus, for example, architectural quality has been used as a common goal for the Danish architectural policy programme (Nygaard, 2006).

When architectural quality is considered as an essentially contested concept eight rhetorical functions appear. These signs are evident in linguistic usage, both in the interpretation of design projects, in a firm's internal policy document and in the European architectural policy programme, which can be found on the homepage of the European Forum for *Architectural Policies* (www.efap-fepa.eu/index.php?lg=en). A close study of policy programs in northern Europe shows how quality is understood in architecture and urban design. Here I would like to point out eight specific functions connected to quality as a key concept with support of Gallie:

An open concept

Architectural quality is an *open concept* built on knowledge. To know what architectural quality is means that one can recognize, explain and account for illustrative examples. Knowledge about quality is obtained through education, professional practice and research. New examples of quality arise continuously in architecture and urban design. Changes create the need for revising, reinterpreting and specifying the contents of the quality concept. There is no final definition of what characterizes good solutions for design problems in architecture and urban design. The concept becomes meaningful through continuous dialogue. Communication is a prerequisite for architectural quality to continue to be a knowledge-based key concept, both for the profession and societal debate.

Architectural quality as an open concept creates uncertainty. In architectural competitions for example the jury must be able to read and interpret drawings, drafts, illustrations and scale models. The challenge lies in understanding the competition's task and the design problems. Qualities in the design solutions become wicked problems (Churchman, 1967, Rittel & Webber, 1973). Wicked problems cannot be solved by traditional analyses. It is impossible to objectively evaluate the solution as being right or wrong. Churchman (1967) describes wicked problems in a social planning context as ill-defined problems that have unique causes, nature and solutions.

Design as a professional practice is embedded with wicked problems. The judgment is based on an open concept. You cannot define and understand design problems out of their specific context. The solution and the problem are connected to each other in architecture and urban design. This point is demonstrated by Cross (1992) when he is quoting an architect who says: "I don't think you can design anything just by absorbing information and then hoping to synthesise it into a solution. What you need to know about the problem only becomes apparent as you're trying to solve it" (p 21). Typical for architecture and urban design is also that there are always many good solutions to the same design problem. One solution is, generally, never overwhelmingly better than another in competitions. This is a wicked problem from the jury's perspective in competitions. Since there are several good solutions to choose from, the jury's quality judgment will be marked by insecurity, a fundamental doubt that normally remains up until the final assessment. This uncertainty is typical among the jury members in architectural competitions where you have to find a winner and it is a consequence of quality as an open concept.

Promoting debates

Architectural quality is a concept that *promotes debate*. There are basic discrepancies in the different views of quality. The concept is controversial. Disagreement is a driving force. The breadth of the linguistic usage reflects the different attitudes toward what quality is, how quality work should be carried out and how quality goals should be expressed in the design of architectural and town building projects. At the bottom of the disagreement lies the desire to steer the agenda in order to acquire interpretation seniority, status in society and assignments. Architects maintain that they are best qualified to judge architectural quality thanks to their education and professional experience. Since there is no single way to solve conceptual differences the debate can continue forever. At the same time there is a need for common understanding within the professional building sector. Building is a collective process accomplished by many professional groups. Shortcomings in quality must be avoided during all phases. With this in mind a debate about quality is used to clarify the concept and help define appropriate criteria for the design and assessment of projects.

In the building sector the discussion on quality has an *aesthetic dimension* and a *technical dimension*. This is a typical foundation for disagreements between architects and engineers at construction companies, at least in Nordic countries. The aesthetic dimension of quality in architecture and urban design is a question of experience and evaluation. The technical dimension of quality concerns traits in products that can be controlled during the production process. These two aspects are very difficult to unite in a quality concept. There is disagreement as to what architectural quality *is*, how appealing environments can be *created*, and how they should be *assessed*. I think we have to accept the fact that there are different ways to understand the concept of quality. They represent different kinds of knowledge. Both the aesthetic dimension and a technical dimension are therefore legitimate in architectural design and construction. Based on this insight we should build “conceptual bridges” to ensure better understanding between the key players in the building sector.

The aesthetic dimension dominated the debate in Denmark during the 1990s. The architectural community launched architectural quality as an offensive and future-oriented solution to the problem of quality shortcomings in building (Nygaard, 2006; Christofersen, 2007). Architectural quality was a goal that had a significant impact thanks to its positive force and ability to define a common direction for architectural policy. The aesthetic dimension in the concept received status and was included in the policy programmes in Denmark (1994 in *Danish Architecture*, in *Architecture 1996* and 2007 in *Nation of Architecture Denmark*). In Swedish discourse shortcomings in building were seen primarily as technical problems. It was expected that promoters and building firms provide the solutions. In 1994, requirements for quality responsibility were incorporated into the planning and building laws. Shortcomings in quality were redressed through measurable requirements, internal controls, and certificates. The reforms stemmed from a technically oriented concept. The aesthetic aspects of the quality concept were highlighted later on in the Swedish debate. That was in 1997 when the government proposed a national policy for architecture and design called *Forms for the future* (Framtidsformer).

Charged with values

Architectural quality is a *concept charged with values*. “This is quality” is a judgment expressed in a complimentary way. The concept infers valuation. Quality is seen as something basically positive, even if often expressed in terms of good/bad and beautiful/unattractive. Such values express either approval or dislike. Quality is then bound to values, which in a decisive way stray from the normalized quality concept incorporated into the ISO 9000 (standard). Quality in this technical perspective is seen as general characteristics, function and performance. They are characteristics that can be measured, guaranteed and controlled (Nashed, 2005; Nelson, 2006). The record is the proof of quality. This is regarded as evidence for how a proposal meets the specifications. The strategy is fault minimization. In this case quality is an operative concept used for controlling, defining and measuring qualities in terms of right and wrong. The difference in viewpoint may be described as the *right quality* and *good quality*. They represent two diametrically opposed ways of relating to the quality concept in the building sector. The right quality means zero defects. Requirements have been implemented. The delivery corresponds to the quality specifications. A product of good quality is

accredited with positive worth and has a certain number of desirable characteristics for someone or something. Good quality assumes that the delivered product is experienced as attractive or appealing.

Value-charged design criteria

Architectural quality is a concept that is interpreted with the help of *value-charged design criteria*. Architecture is judged from criteria which include opinions, values, ideals and impressions of desirable characteristics. Thus a building project may be evaluated externally using quality design criteria based on requirements for suitability to the surroundings, natural materials and a design that spreads joy to the users and visitors. According to Birgit Cold (1989), professor at the Department of Architecture at the Norwegian University of Science and Technology, quality is usually ascribed to beautiful buildings with well thought through functions. That is an example of value-charged criteria describing an architectural attitude that includes values such as wholeness, durability, adjustment to the surroundings, genuineness, aesthetic honesty, beauty, readability, usefulness and professionalism. News-worthiness and originality are criteria that encourage renewal of traditions and overstepping conventions and experience-based professional guidelines.

Another type of value-charged design criteria was found in a Nordic study of architectural competitions at the School of Architecture and the Built Environment in Stockholm 2005-2008. The evaluation criteria in briefs were examined during 1999-2000 (Rönn 2010). These criteria vary from competition to competition. But there was also a stable pattern, a number of design criteria, which appeared time and again in competitions and influenced the jury's quality judgment on a deeper level. All competition entries, in principle, were judged by these design criteria even if they were not specifically outlined in the competition programme. The following design criteria were found in almost every competition brief and jury statement: *Wholeness and fundamental idea*; is there a powerful design idea in the project? *Coherence and surroundings*; how do the proposals fit the site? *Entrance position*; how has the competitor solved the entry into the area, site and buildings? *Suitability and functional set up*; how has the competitor solved the spatial organization in relation to the planned activities? *Economical and technical solutions*; How is the proposal technically produced? *Development possibilities*; To what extent can the proposal be further developed? These design criteria are part of an assessment based on dialogue and have two principal functions. They tell the jury members *what* is important to judge and *how* to proceed. The first step is to direct the juror's attention. This is the "what". The second step is a question and represents the "how". The jury acquires knowledge by posing questions about the proposal. Quality in architecture and urban design is revealed by these design criteria, representing professional ideas about good design.

Learning form

Architectural quality is part of a *learning form* related to design and critical review. Knowledge is developed and expressed by design and the assessment of solutions. This evaluation of architecture and urban design is not true or false. Architectural values cannot be controlled as being scientifically right or wrong. There is simply no empirical support for such conclusions. On the other hand, it is of course possible to formulate well-founded and plausible judgments about what is good for some (designers, clients, end-users) in a specific context. This is what the jury members do in architectural competitions when they select a single winner after examining the best design solutions. Competent assessors, with broad experience from similar cases, may examine quality in terms of goal fulfilment, efficiency, usefulness, technology, artistry and economy. The purpose is not to portray reality but to develop models, concepts and criteria to facilitate the two main aspects of quality work: design and assessment. Quality is visualized and identified by seeing, comparing and interpreting. It is learning based on designated good examples, instructive cases, architectural reviews, critique and reflections about ideal solutions to design problems. Juries for architectural competitions use scale models in their final assessments when choosing a contest winner. Scale models are made of the best entries. These enable the jury to see with their own eyes how the solutions will suit the site. Such models also enable the jury to pose clear quality questions to the participants. It's learning by seeing quality rather than by looking at drawings and illustrations.

The whole

Architectural quality is the combination of elements that form a *whole*. This is fundamental for the assessment of projects, especially in early stages. Quality in architecture and urban design is seen as a *holistic idea* among professionals. Here quality is viewed upon as an overlapping summary: a composite entity of aesthetic dimensions and technical aspects along with requirements for economy, environmental friendliness and social conditions. According to this view it is a combination of aesthetics, technology, economy and environment in a working entity that characterizes the quality concept in the field of design. It is typical for architectural practitioners in the Nordic countries. They understand the concept as a contradiction to the idea of quality as one of several limited aspects of design in architecture, urban design and town planning projects.

The idea of quality as an overlapping and composite entity is a consistent theme in the statement of the 1997 investigation *Architectural Quality (Arkitektonisk kvalitet)* from The National Board of Housing, Building and Planning (Boverket). The Swedish association for architect and engineering firms (arkitekt- och ingenjörsföreningen) states that architectural quality should include aesthetic, functional, technical and social qualities as well as environmental and economical considerations. The Swedish Local Council Organization (Svenska Kommunförbundet) maintains that good architecture can be recognized by the successful blending of aesthetic, functional, economic and technical requirements. The County Government Board (Länsstyrelsen) in Kalmar states that architectural quality is a concept that has a wider scope than just aesthetic design. According to The County Government Board, architectural quality also includes the building's design with regard to function, material, building technology and adaptation to the surroundings.

A specialized way of using history

Architectural quality is part of a *specialized way of using history in practice*. Architectural history produces models for understanding design problems. Time does not move in only one direction. Architects are free to refer to timeless values in new assignments. There is a practical usefulness built into architectural history. Impressions of ageless values are characteristic of their times and solutions. Vitruvius, who was a Roman architect and builder, formulated a quality idea which is everlasting for the architectural profession. Vitruvius describes architecture as an indivisible combination of beauty (*venustas*), function (*utilitas*) and construction (*firmitas*). It is a 2000 year-old tradition that is still flourishing, a canon to posterity that architects continuously refer to in their profession. The quality of architecture lies in the special way the unit is composed with regard to aesthetic form, function and construction. This is a professional, cultural and historically defined way of understanding quality in architecture and urban design (Rönn, 2009).

The historically influenced idea of quality has a practical point of departure. History is a useful subject. The history of architecture is a heritage of many instructive examples. They may be used as reference points for new assignments and inspiration for solutions to design problems. Even quality concepts typical for certain times such as classicism, national romanticism, functionalism, modernism, brutalism, postmodernism, deconstructionism, and new functionalism contain timeless elements in new settings. The everlasting in design is the result of proportions, volume, scale, sight-line, balance, harmony, rhythm and movement. The notion reflects architecture's Vitruvian relationship to fundamental quality questions. The relationships between forms, function, material and construction must be continuously worked on and critically examined.

Interests and design power

Architectural quality is an idea linked to *interests* in society and *design power* in the building sector. Power is portrayed through architecture. Quality is produced by actors with different ideas about the notion's *content, scope and status*. A balance between private and public interests in planning and building laws is part of the balance of design power in society. This balance influences the reach and direction of quality work in architecture and urban design projects. Official statements about proposed changes in legislation are enlightening. Viewpoints concerning the 1997 investigation of architectural quality from The National Board of Housing, Building and Planning are informative.

Several Swedish authorities, including the Gothenburg Town Planning Office (Byggnadsnämnden i Göteborg), wanted to see the law changed so that roads, streets, bridges, town squares and public areas would be subject to architectural quality requirements. Those who oppose this viewpoint consider quality to be a private issue and would rather see the power of public authorities limited. This controversial question also touches upon the extent to which the concept of quality should include aesthetic, cultural-historical, technical, social, environmental and economical aspects.

In its statement Jönköping's County Administration argues that it needs competence in architectural quality when granting building permissions and physical planning. The county administration means they need a city architect at the county level to coordinate the different interest groups in the planning process to reach comprehensive architectural solutions. The Swedish building owner's association (Sveriges Fastighetsägare) on the other hand doesn't wish to see any changes in the law that would interfere with their right of disposition over their buildings. The crucial point is who should decide what architectural quality is. On this matter the building owners association and the home owners (Villaägarnas Riksförbund) association are very clear. The decision should lie with the private owner not the architectural organization, county town planning office or politically appointed persons. According to the National Homeowners' Association, building permission for the detail plan may never be undermined due to unpredictable, vague and poorly defined aesthetic requirements. The county should not be able to impose its aesthetic values on a home owner. Criticism of unpredictable requirements would be troublesome if architectural quality should include aesthetic and technical aspects as well as economical, social and environmental features in the design of the surroundings.

DISCUSSION

From the descriptions it can be argued that the structure of the notion of quality is an "essentially contested concept". Quality has a structure that leads to debate, differences and doubt. But to discuss the concept in a professional context as systematically as possible it is necessary to build up serious conceptions of what should or should not be considered quality in architecture and urban design. The life span and stationary situation of a building makes it available as a public text-book on quality. The notion is also developed through discussion among stakeholders. Through historical retrospect you can learn about the quality ideas that were the focal point of debate during various periods and how architects used these models. Equally interesting is the study of quality questions which recur in the choice of solutions to design problems in architecture and town planning projects. This enables an analysis of vital ideas connected to the concept.

Professionals need well-founded recommendations describing how quality ideas should be understood and carried out in projects. But not a formula with clear-cut criteria for what is "right" or "poor" design, but to find an *appropriate solution* to a design problem. The connection is very important because it gives meaning to the concept of quality. Architecture is an applied art. Architects and clients should both meet the end-users' needs for a well designed space. The global goal is use. The assignment should result in surroundings utilized by people. Clarity and coherency in the design of architectural and town planning projects are aesthetic preconditions for the future utilization of environs. Therefore, good solutions rely upon knowledge of the cultural setting where the project belongs.

The architect's task during the planning process is to give the project the characteristics, which upon completion – with application – generate well thought out values and experiences of architectural quality. The underlying idea is that already in the design stage, before production, the drawings and models enable you to predict future impressions. The ability to design and assess architectural qualities that can be realized in projects and are evident when the consumer uses the building should be the core of professional competence. That is the fundamental challenge for education, professional practice and research in architecture and urban design. I hope that my investigation, demonstration and discussion of architectural quality as a key concept can contribute to this challenge. The concept has to communicate quality in architecture and urban design in a meaningful way in order to be useful in practice.

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Arrière-garde of de-colonization: Critical regionalist research on an Asia-Pacific architecture

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ABSTRACT:

Ever since the early 1980s, when Kenneth Frampton established Alexander Tzonis and Liane Lefavre's concept critical regionalism, definition of its meanings and principles has been a significant discourse in the discipline of architecture. However, along the ever-popular trends of global 'wow architecture,' widely published on the glossy pages of architectural journals, critical regionalism still is not mainstream but rather an underlying stream of thought among a minority of architects, or *arrière-garde* in Frampton's words. Moreover, amazingly little architectural research has been conducted in non-Western cultures in regard to critical regionalism, although its critical undertones appear as successful means in creating context-specific architecture and sense of place, as opposing to the international clichés and uniformity of the built environment across the world.

Hence, this paper explores some possibilities and manifestations of critical regionalism in one geographic setting, that is, the Asia-Pacific region, by providing examples of its applications to this specific framework, including critical analyses of critical regionalism. This is done by examining contemporary architecture in East Asia and Hawaii in terms of cross-cultural and interdisciplinary research. In addition, critical regionalism is discussed as an important and alternative research method of qualitative paradigm in general, and that of emancipatory paradigm in particular. The aim is not only to provide fresh insights into the emerging trends of Asia-Pacific architecture, such as the role of critical regionalism in sustainable design, but also to offer new methods for the research on any culture- and/or context-specific 'language of architecture' with the focus of expanding the discipline's resources both in basic architectural research and design research.

CONFERENCE THEME: Alternative approaches in research methods

KEY WORDS: Tropical architecture; East Asian architecture; Commune by the Great Wall, China; Vladimir Ossipoff, Hawaii; regionalism; sense of place (*genius loci*)

INTRODUCTION

Almost thirty years ago, in "Towards a Critical Regionalism: Six Points for an Architecture of Resistance," Kenneth Frampton stated:

Architecture can only be sustained today as a critical practice if it assumes an *arrière-garde* position, that is to say, one which distances itself equally from the Enlightenment myth of progress and from a reactionary, unrealistic impulse to return to the architectonic forms of the preindustrial past (Frampton 1983b).

The term *arrière-garde*, with such connotations as 'out-of-date' or 'backward,' might appear contradictory, or at least surprising, in the context of a search for a new architectural theory, though Frampton's position naturally is its meaning 'rear guard,' as opposing to, or following the modernist *avant-garde* which according to Frampton "can no longer be sustained as a liberative movement" (Frampton 1983b). Scott Paterson interprets this meaning that modernism became "a self-referential entity whose role in societal change is minimized," while he considers critical regionalism an attempt "to put on the brakes of the *avant-garde* pendulum" (Paterson 1995). The same is implied by the subheading of Frampton's second point, *The Rise and Fall of the Avant-Garde*, in which context he argues that modern *avant-gardism* failed in opposing both the negative impacts of technological expansion and the media-fed consumerism of post-modernism; also revealed by the continuation of the above quote:

A *critical* [my emphasis] *arrière-garde* has to remove itself from both the optimization of advanced technology and the ever-present tendency to regress into nostalgic historicism or the glibly decorative (Frampton, 1983b).

These types of comments in the 1980s were, of course, closely related to the controversy over post-modern architecture, though also to the growing awareness of the ecological concerns related to building industry. The discourse was reminiscent of the reconstruction of the concept of regionalism in architecture in the early and mid 20th century; in the US, led particularly by Lewis Mumford who, at first, in his *Sticks and Stones: American Architecture and Civilization* (1924) reacted against the 'imperial' Beaux Art tradition as 'non-American,' like the earlier European regionalists did with their ties to movements of emancipation. It is rather remarkable that the critical regionalists, a few decades later, in their criticism against the dominance of the so-called International Style found inspiration in Mumford's writings; in addition to *Sticks and Stones*, his *Technics and Civilization* (1934), *The South in Architecture* (1941) and his post-WW II column "Sky Line" in the *New Yorker* (October 11, 1947), followed by later works such as *The City in History* (1961) and *The Urban Prospect* (1968). Also, Paul Ricoeur's writings on the phenomenon of universalization, particularly his "Universal Civilization and Natural Cultures" in *History and Truth* (1965), have served as the philosophical basis of this current discourse on critical regionalism.

One of the milestones in establishing the concept of critical regionalism was, without doubt, the Pomona Meeting in 1989 at the College of Environmental Design of the California State Polytechnic University in Pomona, California, with the *Proceedings* published in 1991 and edited by the prime organizer of the meeting, Professor Spyros Amourgis. In his Introduction to the *Proceedings*, Amourgis states: "While opposing meaningless modernization and vernacular sentimentalism, Critical Regionalism emphasizes context, sensitivity to the environment, history and culture" (Amourgis 1991). Among the many conference papers, Alexander Tzonis and Liane Lefaivre further emphasize that "What distinguishes 'regionalist' from the simply 'regional' is that it incorporates regional elements into design as a means not only of adapting to local conditions but also of criticizing an architecture of order that claims universal application" (Tzonis and Lefaivre 1991). Regarding Mumford, they also point out the allegories of his thinking:

As in every allegory where the *personae* are chosen because of deep structural analogies, so in Mumford's lectures the term "regionalism" is chosen because of the analogies between the old "despotic" order of the Roman Empire and the imperialist "colonization and conquest of Asia, Africa, the Americas" and the new "mechanical order" of the "no less ruthless control of the new kings" of industry with the old academic tradition and the new "international style" (Tzonis and Lefaivre 1991).

Although the term critical regionalism was introduced by Tzonis and Lefaivre in their article "The Grid and the Pathway" as early as in 1981, its definition is yet to be undisputedly established – when comparing the many attempts to define critical regionalism, it is elucidating that most explain what it is *not*. Therefore, the term is here used in its Kantian, or rather neo-Kantian, sense as "test of criticism" and simply as "contemporary regionalism in order to distinguish it from former approaches," to quote Alexander Tzonis in his Preface to the more recent *Critical Regionalism: Architecture and Identity in a Globalized World*, again coauthored with Lefaivre (Tzonis and Lefaivre 2003). Reflecting the many controversies in regard to the meaning of critical regionalism, Tzonis mentions that they have even publicly suggested replacing the term regionalism by realism, "hereby erasing the middle part of 'region'-alism" (Tzonis and Lefaivre 2003).

Nevertheless, emphasized by Tzonis in the introductory chapter of the above book as well, the concept of critical regionalism is still prevalent and perhaps even more prominent than before, due to the conflict between globalization with international interventions, including those in architecture, and the simultaneous search for local identity with, in many cases, the desire for ethnic insularity. On the other hand, in his article "Placing Resistance: A Critique of Critical Regionalism," Keith L. Eggener points out that:

If so-called critical regionalist designs exemplified an "architecture of resistance," it is ironic that writers discussing the places where these designs appeared so often emphasized one architect's interpretation of the region over all others: Tadao Ando for Japan, Oscar Niemeyer for Brazil, Charles Correa for India, and Luis Barragán for Mexico. In other words, a single correct regional style was implied, or imposed, sometimes from inside, more often from outside "the region" (Eggener 2002).

Eggener also criticizes the Euro-America – centralized critical regionalist analyses which “on more than one occasion led to an interpretative flattening of diverse cultural materials, and a misunderstanding or devaluation of their founding intentions and most immediate meanings” (Eggener 2002). By quoting Jane M. Jacobs, he goes even as far as describing critical regionalist rhetoric as “a revisionary form of imperialist nostalgia that defines the colonized as always engaged in conscious work against the ‘core’” (Eggener 2002). From the perspective of de-colonization, this is clearly a relevant point, particularly in terms of the center/periphery thinking, which according to Eggener implies that “No matter how vital, the peripheral is other than, deviant from, and lesser than the center, the norm” (Eggener 2002).

A counter-argument could, however, call attention to the two Scandinavian architects, Alvar Aalto and Jørn Utzon, repeatedly used by the same writers as not only the prime examples of either Nordic regionalists or early critical regionalists (depending on the publishing year). But they also are international designers and global practitioners with influences from various cultures and regions, which Eggener does not mention, though he does emphasize Barragán’s international character, as opposing to his image “romanticized by European and North American – based writers” (Eggener 2002). From the perspective of this paper, for instance, though not revealed by Frampton either, it is worth noting that in an interview in 2004 Utzon, a widely travelled and cosmopolitan architect, mentions that his source of inspiration for the Bagsværd Church in Denmark came from “a vast sandy beach in one of the Hawaiian islands Oahu” (Bløndahl 2005). Utzon’s sketch from the time when he started to design this church illustrates the clouds brought to this beach by the regular trade winds from the northeast and the effect of the sunlight falling through the clouds down to the sand: “It’s a natural space that gives a profound spiritual peace [...] So the natural space that gripped me has been turned into the body of the church” (Bløndahl 2005). For Frampton, in turn, “the only precedent for such form” is “the Chinese pagoda roof,” while the “intent of this expression is, of course, to secularize the sacred form” (Frampton 1983b). Frampton does, though, expand this interpretation to some extent in his ‘third point’ by ‘pointing out’ that “yet paradoxically, this desacralization at Bagsværd subtly reconstitutes a renewed basis for the spiritual, one founded, I would argue, in a regional reaffirmation” (Frampton 1983b).²

While addressing critical regionalist architecture and acknowledging the many views on it, including the critical analyses of critical regionalism, it appears that today there is even more diversity in approaches than before. In fact, this is exactly what Lefaivre states as well: “Not surprisingly, given the unprecedented scale of globalization today, for the first time in history regionalism has become a global movement, or rather a series of movements.”

Moreover, at the turn of the 21st century, it also seems that, instead of resisting any international *style* per se, a *critical* arrière-garde is even more than before needed to resist – or at least stabilize – the global practices of ‘starchitects’ and capitalist strategies of big international corporate design firms. But to what extent has this resistance actually taken place in the past decades in architecture and urban planning? And what has been or could be the impact of critical regionalism on the post-postmodern world and new narratives of de-colonization? Further, and most importantly for this paper, what are the potentials of the developing countries to resist, on the one hand, the nostalgic return to the vernacular models as historicist form giving and, on the other, the negative impacts of global architectural practices?

I. RESISTANCE VS. DIVERGENCE

Looking from Hawai‘i in the heart of the Asia-Pacific region, it appears, indeed, that many of the critical regionalist analyses misinterpret, or at least flatten (to use Eggener’s expression) the meanings of the regional/cultural and/or sub-cultural issues of this particular context. There would be countless examples to discuss in this regard, though in this paper I focus on a few projects in China and Hawai‘i; first of all, in the name of the hermeneutics of phenomenology in having personally experienced these projects, or their sense/spirit of place, if you wish. Second, the goal here, within a very limited space, is to provide information on some projects not included in the book *Tropical Architecture: Critical Regionalism in an Age of Globalization* by Tzonis, Lefaivre, and Stagno which covers much of South and Southeast Asia (in addition to some other cultural spheres in tropics and subtropics) and

well-known tropical regionalists (added with works of the contributors of the book), but also less-known Sri Lankan Minette de Silva and Brazilian Lina Bo Bardi; the latter two underlining the role of the female architects in the discourse on regionalism as well.

But before delving into East Asia and the Pacific region, we might look at Latin America in order to elucidate the meaning of critical regionalism from the viewpoint of Argentine Marina Waisman, according to whom “the Latin American version is quite different from that proposed by Kenneth Frampton, or Alexander Tzonis and Liane Lefaivre” (Waisman 1994). She goes on stating that the Latin American culture, as part of “the general movement of history”, is a “unification of the spirit of times and the spirit of place” and, hence, Latin American contemporary architecture should be “understood as a movement of *divergence* rather than resistance (the term which Frampton prefers.)” Eggener puts the same as follows:

In other words, contemporary Latin American architecture of regionalist character is not primarily a reaction to the West, or to ‘world culture,’ as the word *resistance* would imply, but a response to local circumstances. It should be seen not as a marginal practice, but as a development parallel to contemporary architecture in the industrialized West (Eggener 2002).

Actually, also Lefaivre, in explaining what makes Mumford’s regionalism critical, emphasizes that it “is seen as an engagement with the global, universalizing world rather than by an attitude of resistance” (Tzonis and Lefaivre 2003).³ She further points out that it “stems from his radically critical rethinking of traditional definitions of regionalism” with which Lefaivre refers to the critical philosophy of Immanuel Kant and the Frankfurt School, though she also acknowledges the differences in thinking of these philosophers (Tzonis and Lefaivre 2003).

As for parallel developments beyond the ‘West,’ one sign of the above attitude on contemporary regionalist architecture as divergence rather than resistance in the Asia-Pacific region is the Commune by the Great Wall in China (below simply the Commune for short). This architectural competition, launched by the developer couple (SOHO China Ltd.) Zhang Xin and Pan Shiyi in 2000, was one attempt to showcase Asian architecture with a focus on the use of local materials. The invited Asian architects designed eleven weekend houses and a clubhouse on a scenic site in the Shuiguang Valley outside of Beijing, close to the popular place to climb the Great Wall in Badaling. These twelve projects are: Suitcase House by Gary Chang (Hong Kong), Furniture House by Shigeru Ban (Japan), “See” and “Seen” House by Cui Kai (China), Airport House by Chien Hsueh-Yi (Taiwan), Cantilever House by Antonio Ochoa (China), Distorted Courtyard House by Rocco Yim (Hong Kong), Bamboo Wall by Kengo Kuma (Japan), The Shared House by Kanika R’kul (Thailand), The Twins by Kay Ngee Tan (Singapore), Forest House by Nobuaki Furuya (Japan), Split House by Yung-Ho Chang (China), and the Clubhouse by Seung H-Sang (South Korea). According to Ricky Burdett: “Not only was it the first major Chinese project to be exhibited at the Venice Biennale [in 2002], but it scooped one of the event’s three most prestigious prizes” (Burdett 2004) and as such the Commune certainly was the first time when Asian contemporary architecture attracted international attention to this extent.

Gary Chang’s Suitcase House is included in *Critical Regionalism: Architecture and Identity in a Globalized World*, but examining some other buildings and the complex at large might shed more light into the meaning of critical regionalism in China. From the perspective of Chinese residential typology, namely, the courtyard house, two projects in the Commune are particularly interesting. One is the Distorted Courtyard House, in which Rocco Yim interprets courtyard typology in a deconstructivist way by intertextual, decentered, and dispersed elements (Fig. 1). Another application of the courtyard typology is Yung-Ho Chang’s Split House, in which the two-wing structure splits down in the middle, creating an open courtyard that is connected with the interior spaces of various angles on the sloping site with a small stream (Fig. 2); a classical Chinese method of expressing the macrososm in miniature. The building also features traditional building techniques and materials, in this case, rammed earth walls besides the timber frame.

In regard to local materials, Kengo Kuma’s Bamboo Wall is not only a rather obvious application of bamboo as the vernacular building material in Asia, but also, and much more importantly, an example of the spatial layering using the undefined, yet distinct, boundaries created by bamboo screens of various types and intensities (Fig. 3). This is a rather similar design technique Kuma had



Figure 1: Floor plan of the Distorted Courtyard House by Rocco Yim, Commune by the Great Wall, Badaling, China, 2002. (Burdett 2004)



Figure 2: Floor plan of the Split House by Yung-Ho Chang, Commune by the Great Wall, Badaling, China, 2002. (Burdett 2004)

previously applied to the Hiroshige Ando Museum in Batoh, Japan. This latter is another East Asian project included in *Critical Regionalism: Architecture and Identity in a Globalized World*, in the usage of timber latticework and a grid layout described as “a natural tribute to the centuries-old tradition of Japanese wood architecture,” while “sometimes the grid patterns transform into a solid translucent pane, and at other times they become transparent” (Tzonis and Lefaivre 2003)⁴; I assume this is the authors’ reference to the *shouji*, *fusuma* and *sudare* screens as well as other movable ‘layers’ of traditional Japanese architecture, added with transitional verandas, or *engawa*.⁵



Figure 3: Spatial layering in the Bamboo Wall House by Kengo Kuma, Commune by the Great Wall, Badaling, China, 2002. (Photo by the author)

On the other hand, if we analyze the Commune from one particular criteria of critical regionalism, that is, Mumford’s emphasis on communality, it is obvious that – in spite of its name – it has never been a living commune of any kind. In discussing the wine-growing communities of Burgundy in *The South in Architecture*, for example, Mumford states that the “kind of co-operation and re-adaptation and development is what is necessary to produce a truly regional character” (Mumford 1941) which does not apply to the artificiality of the Commune. In fact, the Kempinski Hotel chain now runs the Commune and has turned it into a highly exclusive and expensive luxury resort for visitors, not for a permanent community. Anyhow, from a purely credulous perspective, it is rather interesting that, in spite of the extremely high prices, this resort (with initial investment of \$24 million) became so popular that several replicas of the original eleven houses have been added in the complex in order to meet the increasing demand for hotel space, and the area now also serves as what could be called ‘an outdoor museum of contemporary Asian architecture.’ In this, we can see similarities to Barragán’s elitist architecture, romanticized in many critical regionalist analyses, which

Eggerer criticizes exceptionally hard:

While Mexican modernist contemporaries such as Juan O’Gorman, José Villagrán García, and Mario Pani built the low-cost, utilitarian schools, housing, hospitals, offices, and factories that were so badly needed in their developing and recently war-torn nation, the aristocratic, elitist, aggressively capitalist Barragán speculated in real estate. He built private refuges in which privileged people of means and sophistication might share in his Proustian meditations on memory, nostalgia, and loss. [...] His elegant walled compounds, elite subdivisions, and equestrian enclaves may, as Frampton has suggested, mark a kind of critique, but it is worth keeping in mind just what sort of critique this was: hardly critical or progressive, but romantic and reactionary (Eggerer 2002).

In comparison to today’s China, in many respects the situation is different from that of post-war Mexico, although real estate speculation certainly dominates China, too, in the so-called ‘socialist market economy,’ a rather paradoxical concept invented by the Chairman of Chinese Communist Party, Deng Xiaoping, for his new ‘open doors policy’ in the late 1970s. Well, it seems that in the unprecedented economic growth of China that followed, the foreign and Chinese architects alike have interpreted Deng’s famous slogan “It doesn’t matter whether the cat is black or white, as long as it catches the mice” in a way which allows profitable practices and exclusive designs for the emerging Chinese nouveau rich, whereas in a developing country, with unacceptable living and working conditions for majority of people, the development of schools, housing, hospitals, offices, and factories as well as infrastructure in general would be in dire need.

As for the global market economy, we should, at the same time, bear in mind the global competition, including that in the field of architecture. Take, for instance, the Beijing Olympics in 2008 for which all the major venues were designed by foreign architects, most notably the main stadium, or the ‘Birds Nest,’ by Herzog and de Meuron (Switzerland) and the swimming stadium, the ‘Water Cube,’ by PTW Architects (Australia), thereby negating the usual advantage of the Olympic Games as an opportunity for the local architects to gain international exposure. The same applies to the various other high-tech building projects, such as the CCTV Headquarters, the ‘Twisted Doughnut,’ by Rem Koolhaas (OMA, the Netherlands) and the National Theater, the ‘Alien Egg,’ by Paul Andreau (France), launched before the Olympics with the intention of portraying China to the rest of the world as a developed and modern country – the nicknames of the buildings given by the local populace expressing better than anything else their perception.⁶ In this respect, the Commune by the Great Wall, however elitist it has become, can be seen as a parallel phenomenon to the development of contemporary architecture across the world, such as the Case Study House Project in California in the 1940-50s (a precedent for the Commune Project), in creating specific sense of place with a particular, new language of Asian architecture; similar to the Californian Case Study Houses, which evolved into regional modern architecture of the US West Coast (also rather elitist, even though the goal was inexpensive mass production of these prototypes). Tzonis and Lefavre describe this characteristic of critical regionalism as follows: “Defamiliarization is at the heart of what distinguishes critical regionalism from other forms of regionalism and its capacity to create a renewed, versus an atavistic, sense of place in our time” (Tzonis and Lefavre 1991).

2. PLACE VS. IDENTITY

Since critical regionalism, especially regarding the concept ‘loss of nearness’ caused by the uniformity of the built environment across the world, revolves around the phenomenological concept *genius loci*, or ‘sense of place’ also translated as ‘spirit of place,’ Martin Heidegger is naturally a philosopher of interest for critical regionalists, besides Maurice Merleau-Ponty and Christian Norberg-Schulz who even more directly address architecture in their writings. However, there are some fundamental differences when comparing Mumford and Heidegger, although both worked simultaneously and were concerned with the juxtaposition of place and community as well as civilization and technology. As pointed out by Lefavre, Mumford understood regionalism as democratic multiculturalism in the spirit of Walt Whitman and Ralph Waldo Emerson, which was in a stark contrast to Heidegger’s nationalistic concept *Volk*, defined by common ethnicity, identity, language, and soil (the place-earth-land-home). This distinction is definitely important to bear in mind in order to avoid ethnic insularity in the search for local identity which sometimes is done in the name of critical regionalism and/or de-colonization.

Mumford expresses the view of regional diversity especially in his *Report on Honolulu* that included a master plan for the city, his only design proposal, published in 1945 and based on his consulting trip to Honolulu in 1938. He describes the place, still very accurately (though he forgets one of the largest ethnic groups, the Philippines), “as a multicultural city, made up of original Polynesians, Japanese and Chinese, and various *Haole* groups (western) which makes it a significant experiment in hybridization of cultures” (Tzonis and Lefaivre 2001). In his plan, Mumford applied the American regionalist ideas of 1930s with greenbelts and superblocs to a garden city, or a “great park,” as Mumford called Honolulu (Tzonis and Lefaivre 2001). Although he did not mention the concept *ahupuaʻa*, the traditional land division of Hawaiian island from the mountains to the sea which has recently seen a rebirth in some community plans in Hawaiʻi, important in his plan for Honolulu was to provide views of the mountains from the city and its park zones.

Another dissimilarity between Mumford and Heidegger is their attitude towards technology. While “Heidegger’s thought is grounded in a deeply anti-modernist attitude [...], Mumford believed that regionalism was synonymous with modern,” according to Lefaivre (Tzonis and Lefaivre 2001). Mumford was, however, also concerned with what is today called sustainable design, which he described in the *Technics and Civilization* as the “biotechnic age” of the future, following those days’ “neo-technic order” (Tzonis and Lefaivre 2001). In short, the aim of this biotechnic regionalism was the balance between man and nature, including conservation and restoration of soils and forests. Quite contradictorily to sustainability, though, but in line with modernist ideas, Mumford supported the use of air conditioners in his *Report on Honolulu* and the modernist ‘belief in machine’ is also expressed in his *Technics and Civilization*.

A totally different response to Hawaiian climatic conditions is seen in the works of Vladimir Ossipoff – some say “the best kept secret of Hawaiian architecture.” (I do wonder why was he not among the regionalists in the *Tropical Architecture* by Tzonis, Lefaivre, and Stagno?) Ossipoff himself is an interesting and cosmopolitan personality; he was born in 1907 in Vladivostok, Siberia, spent most of his childhood in Japan where his father was the Russian czar’s military attaché, studied architecture in 1927-31 at the University of California, Berkeley, and after his graduation worked in Hawaii till his death in 1998. In terms of de-colonization, it is worth noting that his career coincided with the transition of the annexed Territory of Hawaiʻi into the statehood in 1959, making Hawaiʻi the 50th state of the United States, in which process place making was momentous in the creation of the new identity of Hawaiian islands. And Ossipoff’s architecture was part of it, in contrasting to the historicism of the colonial period, as described by Dean Sakamoto in *Hawaiian Modern: The Architecture of Vladimir Ossipoff*:

Ossipoff participated in the appropriation of the principles and materials of modern architecture and transformed them into a specific local geographic manner that was adapted visually and ecologically to a sound engagement with the environment and with the cultural reality of the region (Sakamoto, Britton, and Murphy 2007).

Among Ossipoff’s numerous public and private buildings, only the Liljestrand House is discussed here, as in this limited space it sufficiently represents the main ideas of his design philosophy (Fig. 4). Not surprisingly, in this house built in 1952, as in most Ossipoff houses, Japanese influence is seen in deep eaves, open floor plan, indoor-outdoor connection, verandas, natural wood and timber members, built-in cabinets, and understated, confined entry that opens into a magnificent view over the city. These as well as other carefully designed details that hide and reveal the interior and exterior features are clearly similar to Japanese design methods and, indeed, in his article “The Japanese House” Ossipoff even states that “Japanese house is better suited to Hawaiʻi than it is to Japan” (*Hawaiʻi Architect*, March 1986). Given the impact of the Japonisme movement on modern architecture, these features can, of course, be seen as integral part of modernism as well.

Significant in all Ossipoff’s projects was a careful analysis of both the macro and micro climate of the site, not only leading to excellent siting, but also to the maximization of the trade winds and the passive cooling of natural ventilation. No air conditioning is needed due to the clever use of Venturi principle according to which a flow of air from the smaller openings on the windward side of the building, with larger openings on its leeward side, allow constant ventilation through the house without causing too strong drafts (Sakamoto, Britton, and Murphy 2007). In Liljestrand House, this is achieved by small louvers above the corridor windows on the mountainside in the north (above 6s in the floor plan, Fig. 5) and wide sliding doors on the other side on both floors (Fig. 6).



Figure 4: Liljestrand House seen from the pool. (Photo by Robert Liljestrand)

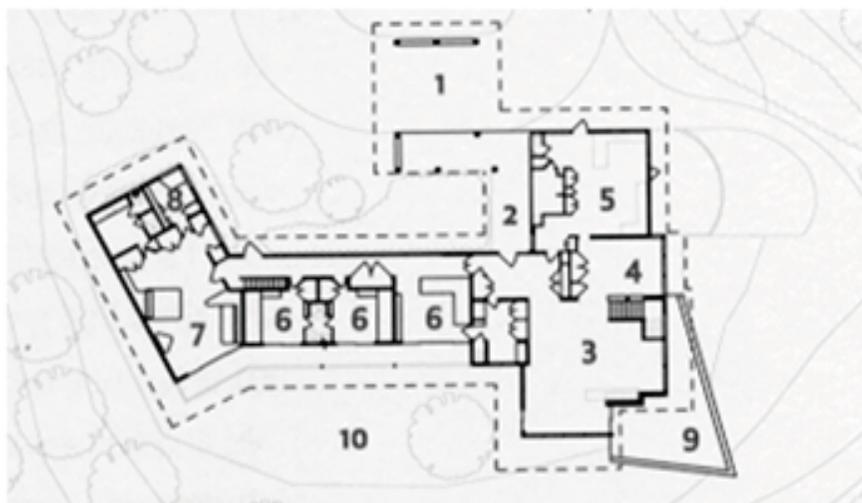


Figure 5: Floor plan of the Liljestrand House: 1 carport, 2 entry, 3 living room, 4 dining room, 5 kitchen, 6 bedrooms, 7 master bedroom, 8 study, 9 deck; in the ground floor, a family room below 3, and a recreational room below 6s open to 10 lawn. (Sakamoto, Britton, and Murphy 2007)

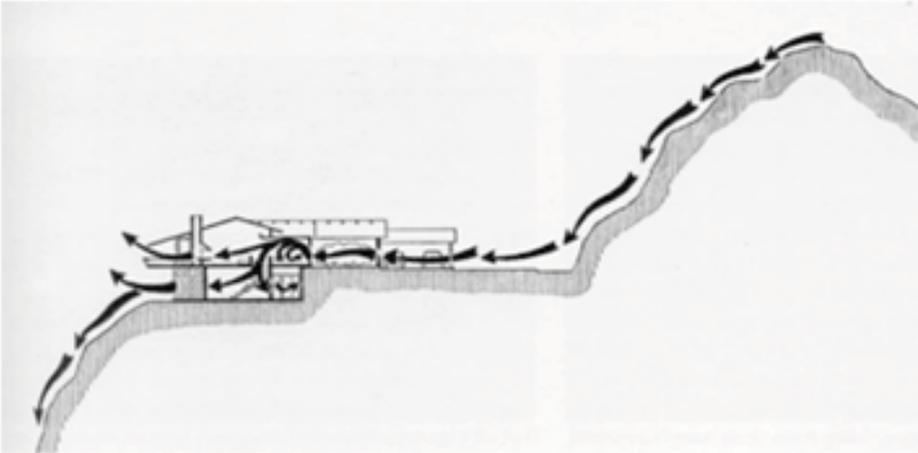


Figure 6: Section drawing of the Liljestrand House showing the natural ventilation created by the trade winds blowing from the mountains through the building. (Sakamoto, Britton, and Murphy 2007)

Ossipoff's regionalism, like his life, was a vivid juxtaposition of various cultural elements, though deeply grounded in the Hawaiian context and its multiculturalism. Besides the obvious Japanese influence, the architectural education in California is apparent with similarities to the Bay Area and Southern California architecture as well as American Arts-and-Crafts movement; Ossipoff also witnessed the construction of Wright's Imperial Hotel in Tokyo where his family is reported to have had tea parties (Sakamoto, Britton, and Murphy 2007). In the Californian tradition, Ossipoff was following the same line of thinking than Mumford and, in fact, in his "Sky Line" column Mumford argues that the Bay Region style is more international than the so-called International Style because it is a "product of the meeting of Oriental and Occidental architectural traditions" (Tzonis and Lefaivre 2003) and thus allows regional adaptations and modifications. Furthermore, in the foreword of *Hawaiian Modern*, Frampton points out "a transpacific link to the emerging subtropical manner of Minette de Silva and Geoffrey Bawa in Sri Lanka in the 1970s" (Sakamoto, Britton, and Murphy 2007). Ossipoff's architecture also has links to such contemporaneous tropical regionalists as Henry Klumb in Puerto Rico, Ricardo Porro in Cuba, Richard Neutra in Havana and Puerto Rico (besides his works in the US and Europe), Oscar Niemeyer in Brasil, and Paul Rudolph in Florida, to mention just a few.

CONCLUSION

As one of the goals of critical regionalism is 'place making,' its role in defining the place, the genius loci, is naturally crucial. In addition, adaptive reuse of existing built environment could also be regarded as one of the future possibilities and manifestations of critical regionalism in the Asia-Pacific context in terms of preservation of buildings that are part of the sense of place of their location, thereby giving meaning to the historic layers of the built environment and defining the uniqueness of the place. Because adaptive reuse is evidently related to the '3 Rs' of sustainable design: reuse, recycle, and reduce; while ecological consciousness, in turn, is an integral part of critical regionalism, there is a clear connection between both. And as this juxtaposition is supplemented by the context-specific considerations of the historical, cultural, and social features of the place, critical regionalism is not only one of the parallel design trends within the global context, but also a decisive research tool in analyzing context-specific architecture. Amourgis puts it as follows: "During the course of the Pomona Meeting, three tendencies became apparent, not as singular directions but rather through differing emphases on (a) environmental, (b) historic/cultural, and (c) social values" (Amourgis 1991). The same applies to numerous architects working in Asia and the Pacific, such as those involved in the design of the Commune by the Great Wall in China, as well as to the regionalist

architecture of Vladimir Ossipoff in Hawai'i.

It might also be worth emphasizing that the goal of this paper has not been to label particular architects in East Asia and/or the Pacific as "Critical Regionalists." Quite the contrary, critical regionalism is here regarded as a multitude of critical approaches to contemporary architecture, both in terms of design and research, both with tectonic and tactile considerations.

As for the emancipatory aspect of critical regionalism, Eggener points out that "critical regionalism is, at heart, a postcolonialist concept" (Eggener 2002) which is rather obvious in the postcolonial world where the concept appeared. In terms of architectural research on decolonization, critical regionalism is increasingly important critical theory in its transformative approach in addressing dynamics of power and marginalization of social groups. In regard to emancipation, this refers specifically to social, gender, and economic equality, internationally and locally, in the ever-continuing development of architecture as a reflection of the culture that created it – poetically expressed by Juhani Pallasmaa:

The present concern with regionalism has the evident danger of turning into sentimental provincialism, whereas vital products of art in our specialized culture are always born from an open confrontation between the universal and the unique, the individual and the collective, the traditional and the revolutionary (Pallasmaa 2007).

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ENDNOTES:

¹Following this rationale, one could also ask, why is Shigeru Ban, one of the most ecologically and socially conscious architects in Japan, not mentioned in any of the critical regionalist analyses, while Tadao Ando is usually regarded as *The Japanese critical regionalist*.

²With the Chinese pagoda roof, Frampton refers to Utzon's seminal essay "Platforms and Plateaus" in 1963 – a decade before the design of the Bagsværd Church (!) – while this Hawaiian source of inspiration has, for long, been a part of the 'oral lore' at the UH School of Architecture, where Utzon was teaching in 1971-75. However, the first formal citation I am aware of on the connection between Hawaii and the Bagsværd Church, built in 1974-76, is in the *Jørn Utzon Logbook*, Vol. II, published in 2005 (Bløndahl 2005), which explains why Frampton does not mention this fact in his articles in the 1980s and 90s. Also, although Nordic regionalism is way beyond the scope of this paper, I cannot resist the temptation of mentioning Alvar Aalto's various sources, including not only Finnish, but also international ones, most notably Japanese influence. (I am born and raised in Finland and, due to my architectural education at the Helsinki University of Technology, rather familiar with his works, although I later specialized in East Asian architecture.) As for Aalto's regionalism, I have often wondered why his Säynätsalo Town Hall is mentioned in almost all publications on regionalism *and* critical regionalism – no doubt because of Frampton – even though Villa Mairea would be another relevant example of Aalto's regionalism in terms of expressing true universalism. More on Japanese impact on Villa Mairea and modernist architecture in general, see e.g., Kim, Hyon-Sob, 2009. "Alvar Aalto and Humanizing of Architecture." *Journal of Asian Architecture and Building Engineering*, May 2009/16, pp. 9-16; and Kim, Hyon-Sob, 2009. "Cross-Current Contribution: A Study on East Asian Influence on Modern Architecture in Europe." *Architectural Research*, Vol. 11, No. 2 (December 2009), pp. 9-18.

³It must be pointed out, here, that this Lefaivre quote is from *Critical Regionalism: Architecture and Identity in a Global World* (p. 34), published in 2003, and might well be a respond to Eggenger's *Placing Resistance: A Critique of Critical Regionalism*, first published in 2002, though Lefaivre does not cite Eggenger's work.

⁴Despite the typically informative introductions by Tzonis and Lefaivre in *Critical Regionalism: Architecture and Identity in a Global World*, and the excellent article "Critical Regionalism: A Facet of Modern Architecture sine 1945" by Lefaivre (though almost the same than in *Tropical Architecture: Critical Regionalism in the Age of Globalization*), I must say that the project analyses in this book are amazingly 'thin,' unfortunately making it more like a 'coffee table book' than anything more worth citing. I might also add that, although the Great Wall of China is in the close proximity of the Commune, it is not actually visible from the area, as claimed by Tzonis and Lefaivre.

⁵For more on my interpretations of the spatial concepts and layering principles of East Asian architecture, see Sarvimäki, Marja, 2003. "Layouts and Layers: Spatial Arrangements in Japan and Korea." *Sungkyun Journal of East Asian Studies*, Vol. 3, No. 2, 2003, pp. 80-108.

⁶For more on critical analyses on the architecture of the Beijing Olympics, see e.g., Lahdenperä, Johanna, and Sarvimäki, Marja, 2005. "Beijing Image: Global and Local in the Promotion and Architecture of Green Olympics 2008." Rockwood, David, and Li, Xiangning (eds.) *Proceedings for the 6th International Symposium on Asia Pacific Architecture*, June 9-11, 2005. University of Hawaii and Tongji University: Honolulu and Shanghai.

⁷More on adaptive reuse in China in my article "Reverse Cultural Revolution: Preserving Bauhausian Architecture in Beijing." *Interventions and Adaptive Reuse*, Vol. 2, 2011.

Learning from Lafitte: An Interdisciplinary Place-based Approach to Architectural Research and Education

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ABSTRACT:

An innovative trans-disciplinary research studio stack, designed to engage issues of coastal sustainability from a place-based perspective, is entering its second year at LSU School of Architecture. Pursued simultaneously through nested design studios, seminars, and independent scholarly research, these educational and research agendas are supported by the Coastal Sustainability Studios (CSS), a University-wide research initiative focusing on collaborative inter-disciplinary proposals for Coastal Louisiana. Faculty and students from the Departments and Schools of The Coast and the Environment, Earth Sciences, Renewable and Natural Resources, Engineering, Architecture, Landscape Architecture, Law, Economics, Geology, Geography and Anthropology collaborate on regional to community scale speculations throughout the lower Mississippi delta. This paper utilizes a CSS geography-based grant to test an NSF funded Long-Term Ecological Research (LTER) framework, developed to facilitate socio-ecological research, within the context of generating proposals for coupled built architectural and natural systems. By furthering the 1977 Venturi, Scott Brown, Izenour research methodology developed in “Learning from Las Vegas”, through the integration of ecological and socio-cultural dynamics, time, and feedback loops (essential considerations within the dynamic deltaic system), a long-term architectural design and education research agenda that provides productive definitions of sustainability and resilience is emerging.

CONFERENCE THEME: Approaches

KEYWORDS: trans-disciplinary, coastal-sustainability, long-term, place-based, studio

INTRODUCTION

The geography of the Louisiana coastal Mississippi Delta is challenging for architecture because the terra firma on which architects typically set their buildings is dissolving at an alarming rate. Louisiana lost 1,900 square miles of land, roughly the size of the state of Delaware, between 1932 and 2000, (USGS, 2005). The underlying causes for this alarming rate of change and future land loss projections are only understood through multiple disciplinary lenses including hydrology, coastal ecology, natural resource management, and civil engineering (not inclusive). More traditional architectural studio research methods yielded fragmented conceptual models of the built and natural deltaic system which resulted in challenges for faculty and students engaged in architectural research, scenario building and design. We are currently developing an alternate conceptual framework developed to facilitate long-term socio-ecological research that was brought into the CSS studio space originally by a coastal ecologist. Through the integration of ecological and socio-cultural dynamics, time, and feedback loops, essential considerations within the dynamic deltaic system, a long-term architectural design and education research agenda that provides productive definitions of sustainability and resilience is emerging.

This trans-disciplinary practice, which facilitated the introduction and ultimate utilization of the Collins et. al. “Press Pulse Dynamics Framework”, can be seen as an extension and expansion of the interdisciplinary approach proposed and initiated in the Learning From Las Vegas (LFLV) research studio and publication. Beginning in the 2010 fall semester, Louisiana State University School of Architecture (LSUSOA) is experimenting with an trans-disciplinary research studio stack, designed to engage issues of coastal sustainability from a place-based perspective. In conjunction with, and partially funded by the Coastal Sustainability Studio (CSS), a University-wide research initiative,

through which faculty and students from the Departments and Schools of Coastal Ecology, Earth Sciences, Natural Resources, Engineering, Architecture, Landscape Architecture, Law, Economics, Geology, Geography and Anthropology collaborate on regional to community scale proposals for coastal Louisiana, the Architecture school is pursuing nested research/design studios, seminars, and independent scholarly research located in the geography of Lafitte, Louisiana.

Similar to the LFLV studio which was “a technical studio...evolving new tools: analytical tools for understanding new space and form, and graphic tools for representing them” (Venturi, Scott Brown, Izenour, 1977, 73) the LSUSOA/CSS research is innovating trans-disciplinary methodology necessary to conceptualize the complexity of deltaic processes. The physical and operational structure of the lower Mississippi coastal delta is a dynamic set of natural and man-made circumstances that are evolving politically, economically, socially and environmentally through time, the most impactful (and least desirable) is land loss. Like Las Vegas, the delta “space is so different from the docile spaces for which our analytical and conceptual tools were evolved that we need new concepts and theories to handle it.” (Venturi, Scott Brown, Izenour, 1977, 75). These new concepts and theories are increasingly modeled in systems theory and are understood to perform according to ecological non-equilibrium theory. A delta, like a

“city is a set of intertwined activities that form a pattern on the land. The Las Vegas Strip is not a chaotic sprawl but a set of activities whose pattern, as with other cities, depends on the technology of movement and communication and the economic value of land...The aim here is for us as designers to derive an understanding of this new pattern.” (Venturi, Scott Brown, Izenour, 1977, 76)

A delta, like a city is a complex system in flux. In order to study such a geography accurately and responsibly, it was and is essential to elicit the collaboration of other disciplines, a task that often requires open minds, intense translation skills, and patient communication. For the LSUSOA, the context of the CSS actualizes this exchange and support.

This paper utilizes the structure of the LFLV 2nd Edition publication to structure its findings and argument. In Part 1, the Collins et. al. “An Integrated Conceptual Framework for Long-Term Social–Ecological Research” is introduced as a Press-Pulse Dynamic (PPD) research framework encompassing multiple fields linked through dynamic process. Within this framework, formal and theoretical architectural observations and positions now become drivers or effects of larger environmental processes. The framework also facilitates the insertion of time and feedback loops in relation to sustainability, which has proven difficult for the discipline of Architecture to incorporate in a sophisticated way. Ultimately, the PPD provides a framework through which architectural research can be more rigorously tested and design process can be inserted into larger temporal/spatial environment.

In Part 2 the preliminary findings, circumstances and architectural implications of Lafitte, LA, are explored through the lens of LFLV. Though highly innovative and useful in 1977, at the time of the publication of the LFLV 2nd Edition, today the methodology provides underlying hints as to spatial/temporal functioning and land-water interface, operational behaviours critical to informing good design. In addition, LFLV provides a framework through which to understand spatial implications of a linear system. Like the Las Vegas strip, Lafitte, LA is a linear swath of development sitting on the high ground of a natural levee.

Though its historical significance is undeniable, recent scenario building and designing through the lens of the partially-informed methodology of LFLV has produced only partially operational architectural proposals. Today, our architectural understanding is more sophisticated and our ability to work inter-disciplinarily has revolutionized our ability to understand and model why Lafitte is so remarkable as a site where dynamic natural forces are so operational that ultimately architecture cannot ignore them and survive.

In Part 3 we present the Manifesto: a framework through which we can combine LFLV and Collins et. al. into a coupled human-nature methodology for architecture. And in Part 4 we examine additional dimensions of the system that complete a socio-ecological framework for design.

PART I: THE TRANS-DISCIPLINARY MODEL

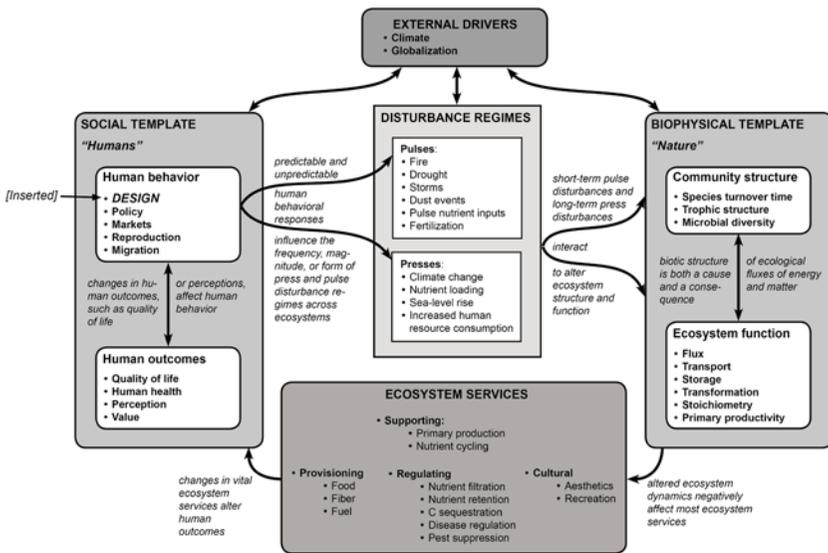
(Bringing LFLV into the 21st Century)

In 1977, LFLV cracked the autonomous architectural envelope utilizing two strategies simultaneously: shock value and trans-disciplinarily. They shocked the architectural community with their assertion that previously “taboo” geography of the Las Vegas strip was worthy of spatial exploration. Then they borrowed theory from Sociology, Semiotics and other disciplines and incorporated the operations of time and speed into their analysis.

Today, a similarly revolutionary paradigm shift can be produced by further expanding framework through which architectural space can be analysed. The Integrated Conceptual Framework for Long-Term Social–Ecological Research provides the framework through which this is possible. By inserting “design” as a behaviour within this

“iterative framework [driven by] ‘Press–Pulse Dynamics’ (PPD), that integrates the biophysical and social sciences through an understanding of how human behaviours affect ecosystem processes. Such dynamics and processes, in turn, influence ecosystem services –thereby altering human behaviours and initiating feedbacks that impact the original dynamics and processes.”
(Collins et al., 2010, 2)

The PPD framework is “hypothesis driven, iterative, scalable, mechanistic, generalizable” (Collins et al., 2010, 5+7) while providing a service-based framework (services are provided by both architectural constructions and natural ecosystems; through the lens of services built and natural forms can be valued commensurately and considered as components of one system) which easily accommodates the insertion of the design process.



The PPD framework provides the basis for long-term, integrated, social–ecological research. The right-hand side represents the domain of traditional ecological research; the left-hand side represents human dimensions of environmental change; the two are linked by ecosystem services and by pulse and press events influenced or caused by human behavior (bottom and top, respectively).

Figure 1: The PPD framework provides the basis for long-term, integrated, social–ecological research, ...” explicitly articulates the reciprocal relationship between the biophysical and social templates through press–pulse events and changes in the quantity or quality of selected ecosystem services.” (Collins et al., 2010, 4). (Adapted from Collins et al., 2010)

“The PPD framework contains four core components: (1) press and pulse events, (2) a biophysical template, (3) ecosystem services, and (4) a social template [where the design process is inserted]. The biophysical and social domains (areas of study) represent traditional disciplinary research paradigms that define processes within each domain. The biophysical template (e.g. geology, hydrology) constrains fundamental and well-documented relationships between biotic structure and ecosystem functioning, whereas the social template (e.g. legal regulation, social networks) encloses a range of possible human outcomes and behaviours, and the dynamics between them.” (Collins et al., 2010, 3)

Press events are typically sustained and chronic such as climate change or sea-level rise, while pulse events are relatively discrete and rapidly alter species abundances and ecosystem functioning such as hurricanes or springtime flood sediment deposition. (Most ecosystems have a characteristic natural disturbance regime that includes the size, frequency, and intensity of pulse disturbances) interactions + feedbacks.

Ecosystem services drive the relationship between the Social template and the Biophysical template within the PPD Framework. Humans intentionally alter the Biophysical in order to extract natural resources, so critical for our survival and prosperity, ultimately providing the “pull” that puts the framework into motion. Ecosystem services are defined by the Millennium Ecosystem Assessment in the figure below.

In addition to what is outlined above, the overarching value of the PPD Framework ultimately lies in its ability to put humans within an activated hierarchical system where we are empowered correctly understand and accurately alter our behaviour within the system:

“Moving environmental science to a new level of research collaboration, synthesis, and integration requires a shift from viewing humans as external drivers of natural systems to viewing them as affected agents acting within social–ecological systems (Grimm et al. 2000) – agents that depend on ecosystem services across a range of scales and feedback cycles. As the human population continues to grow, with attendant land-use, technological, and economic changes, it will place additional demands on vital ecosystem services (MEA 2005).” (Collins et al., 2010, 7)

Designers viewed as “affected agents acting within social–ecological systems” (Grimm et al., 2000) positions them properly within the hierarchy of a dynamic environment, facilitating a more accurate understanding of how design influences the environment, and how it can more effectively do so in relationship to the preservation and proliferation of the ecosystem services that facilitate life on the planet.

“Ecosystem services are the benefits people obtain from ecosystems.”

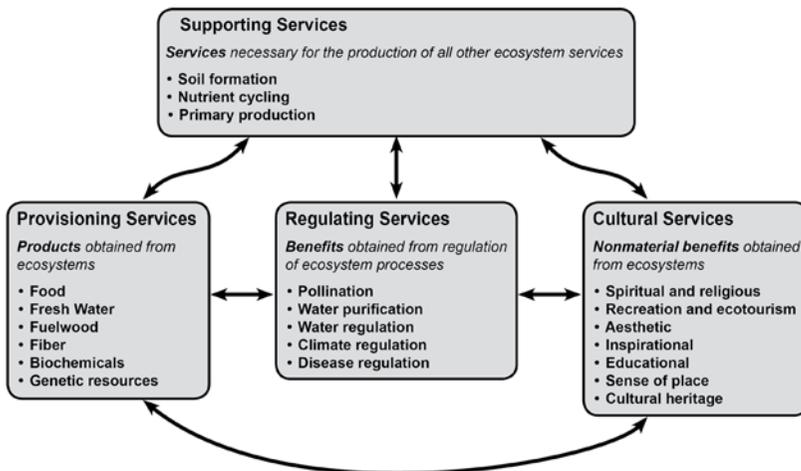


Figure 2: Definition of Eco-System Services.
 (Millennium Ecosystem Assessment, 2005)

PART 2: SIGNIFICANCE FOR LAND LOSS, OR LEARNING FROM LAFITTE

(Significance for A&P Parking Lots, or Learning From Las Vegas)

The operation of land loss is critical to the understanding of the lower Mississippi Delta, and to the geography of Lafitte, LA. Not only does it encompass the diverse and dynamic set of biogeochemical and socio-cultural circumstances that have evolved over the course of history, the land-water interface provides the substrate on which architecture is physically placed. This atypical condition forces architecture to innovate by addressing the larger contexts built and natural systems and cause and effect relationships. As Venturi and Scott Brown knew, “Learning from the existing landscape is a way of being revolutionary for an architect...to question how we look at things” (Venturi, Scott Brown, Izenour, 1977, 3) “In [their] research studio, which was explicitly directed at architects, they were concerned with linking scientific and scholarly research with architectural design” (Stierli, 2008, 13) work that the CSS is furthering through its trans-disciplinary space and approach.

This space is full of scientists who are trained to view the world objectively, a skill that is not developed in most architectural educations and practices. “Architects are out of the habit of looking nonjudgmentally at the environment, because orthodox Modern architecture is progressive, if not revolutionary, utopian, and puristic; it is dissatisfied with existing conditions.” (Venturi, Scott Brown, Izenour, 1977, 3) The flip side is that scientists are not trained to, and often have discomfort associated with altering the environment, a skill architects perform through design education, practice and research. The two fields need each other’s frameworks, skills and expertise to actualize meaningful change in an increasingly complex and dynamic environment.

2.1: ENVIRONMENTAL VALUES AND ENVIRONMENTAL METHODS

(Commercial Values and Commercial Methods)

Like LFLV, proper site analysis is critically linked to complex and dynamic deltaic conditions. Elevation change is so subtle, yet so linked to water level which is constantly shifting depending on tide and wind that is it difficult to understand where the land is, where the site is, what the site is, today and into the future. The “representational techniques learned from architecture and planning impede our understanding of” (Venturi, Scott Brown, Izenour, 1977, 75) that deltaic system. It is essential that representation and communication are innovated in order to facilitate understanding between diverse groups of academics and stakeholders. The implication is that architectural representation becomes more quantitative and that scientific representation becomes more qualitative and visual. The result: that scientists, social scientists, architects and stakeholders can communicate and problem solve in a more sophisticated way.

2.2: ARCHITECTURE AS LANDSCHAFT

(Architecture as Space)

The spaces and forms created by the unique landscape of the Mississippi Delta dictate the spaces and forms that architecture and infrastructure can create. Architecture is pushed and pulled outside of its typical building scale, is mated with infrastructure, is grafted onto ecology. It is only through architecture as a hybrid condition that sustainability and resiliency can begin to be addressed in a sophisticated manner, since the building is always just a component of the larger environment through which it interfaces. The delta is inherently a difficult dynamic environment for humans to inhabit; highly resistant to built form. This dynamism is simultaneously the mechanism through which the system’s abundant resources are produced, the reason humans want to inhabit it in the first place.

2.3: ARCHITECTURE AS TIME

(Architecture as Symbol)

Beginning in 1929, in response to catastrophic flooding, the Army Corps of Engineers began the regional scale project of fixing or hardening this dynamic deltaic system through the construction of levees. Once protected behind levee walls, land appears safe from the destructive forces of water and suburban development, similar to that build all over the terra firma of America, began. Today, after immense investment in infrastructure, subsidence and sea-level rise threaten this development pattern. How do we understand the forces threatening this development so that we can design utilizing them? In an environment where everything is as temporal as it is spatial, where the temporal dictates the spatial, how can architecture address time in its process; potentially even privilege time over space?

2.4: OPERATION IN SPACE BEFORE FORM IN SPACE: LAFITTE AS AN INFRASTRUCTURAL SYSTEM

(Symbol in Space Before Form in Space: Las Vegas as a Communication System)

Architecture operates first and foremost in the dynamism of the delta as a systemic process, then as autonomous form. Autonomous form is inherently problematic in a landscape of substrate deletion. In this context, infrastructure becomes dominant over space. How can communities restructure to embrace this?

2.5: LINEAR SPACE IN THE BIOGEOCHEMICAL HISTORICAL TRADITION AND IN LAND LOSS

(Vast Space in the Historical Tradition and at the A&P)

Rivers create natural levees or high grounds parallel to their banks as flooding occurs, this flooding carries sand and soil particulate matter which is deposited as sediment once the waters become stagnant. These high grounds are linear spaces, the substrate of deltaic development.

2.6: MAPS OF LAFITTE

(Maps of Las Vegas)

The delta is flat and subsiding. What small elevation change exists is so subtle, yet inextricably linked to water level which is constantly shifting depending on tide, wind, storm surge, etc. These conditions make conventional mapping almost impossible, and not terribly meaningful. Additionally, because of the thick vegetation, vistas are rare. It is difficult to spatially locate on the ground in the delta.

2.7: MAIN STREET AND THE BAYOU

(Main Street and the Strip)

Because the river has created natural linear levees along its banks, the few roads that could be built in the delta were placed on or near these high grounds creating a system of 2 parallel linear modes of movement, one by boat and the other by car. Residences and retail were constructed on the high ground between creating a unique access situation. One door to the house fronts the water and the other door fronts the road, ultimately bringing the location of the front door into question. Pre-road, it existed clearly on the water side; today it is difficult to say.

2.8: SYSTEM AND ORDER ON THE HIGH GROUND

(System and Order on the Strip)

The order in this landscape is not obvious” (Venturi, Scott Brown, Izenour, 1977, 20) or clearly evident from the current spatial configuration of Lafitte. An analysis of current and historical activity is required to understand the evolving patterns of small scale working class residential, large scale McMansion residential, small scale fishing, shrimping and local retail and large scale oil and gas and transportation industries which make up the majority of the built environment.

2.9: CHANGE AND PERMANENCE ON THE HIGH GROUND

(Change and Permanence on the Strip)

Change is first and foremost driven by dramatic natural flooding and hurricane events. Industrial and residential economies also play a dramatic role in population size and demographic. Socio-cultural change tends to be slow as family ties and local culture and lifestyle are valued by multiple generations.

2.10: THE ARCHITECTURE OF THE HIGH GROUND

(The Architecture of the Strip)

Architectural types in Lafitte have varied dramatically through time and space. Vernacular architecture dealt with structural and geotechnical issues by suspending structures on piers, by floating them as boats, or utilizing minimal construction so that they were expendable in hurricanes and would relatively easily be rebuilt. Waterproofing and wind proofing was addressed through use of loose/thin envelopes and long/thin footprints. Trap doors in 2nd stories were employed to drain floodwaters and techniques to temporarily secure buildings and equipment for evacuation were common. In this environment, one cannot consider the architecture of hurricanes without a discussion of evacuation behavior.

Current architectural types deal with structural and geotechnical issues via slab on grade construction, elevating homes, or suspending trailers inside structural boxes on stilts. Waterproofing is addressed through elevation of the living spaces within homes, or of the entire house, the lack of drywall installed on the bottom 4 feet of walls or is not addressed at all. Windproofing typically comes in the form of balloon framing built to current wind-load code, masonry construction and hurricane shutters.

2.11: ARCHITECTURAL CONNECTIVITY AND THE SMALL, HIGH SPACE

(Architectural Monumentality and the Big, Low Space)

Occasional new developments have emerged that connect tightly packed residences on the 2nd story through the main porches and living spaces. These developments are seemingly inspired by Vietnamese Fishing Villages and facilitate weather protection, air circulation in summer, and pedestrian circulation and community.

2.12: LAFITTE STYLES

(Las Vegas Styles)

Lafitte has been occupied pretty much continuously from the late 1700's to today. Dynamic conditions have encouraged a visual and functional hodge-podge approach to the built environment. Examples of all of the following architectural types are present in the town: Shotguns, Galleried Creole Cottages, Bungalows, Plantation-like buildings, Quarters Type Cabins, Trailer on Stilts, Victorian, Classical Style, Greek Revival, Georgian, Ranch, and Neoclassical Colonial Revival McMansion.

2.13: INCLUSION AND THE DIFFICULT ORDER

(ibid)

This visual and functional hodge-podge approach to the built environment makes it particularly difficult to tease out the underlying order of the geography. “It is not an order dominated by the expert and made easy for the eye. The moving eye in the moving body must work to pick out and interpret a variety of changing, juxtaposed orders...” (Venturi, Scott Brown, Izenour, 1977, 53) The order certainly cannot be arrived at through analysis of architecture alone; environmental, economic and other drivers of change have had as much to do with the physical expression of Lafitte, but have left a softer mark on the landscape.

“Henri Bergson called disorder an order we cannot see. The emerging order of [Lafitte] is a complex order. It is not the easy, rigid order of the urban renewal project or the fashionable ‘total design’ of the megastructure. It is, on the contrary, a manifestation of an opposite direction in architectural theory: Broadacre City—a travesty of Broadacre City, perhaps, but a kind of vindication of Frank Lloyd Wright’s predictions for the American landscape.” (Venturi, Scott Brown, Izenour, 1977, 52)

2.14: IMAGE OF LAFITTE: INCLUSION AND ALLUSION IN ARCHITECTURE

(Image of Las Vegas: Inclusion and Allusion in Architecture)

Like Las Vegas, Lafitte is a kind of pleasure zone with tourist driven swamp tours, boating and sport fishing amenities, and McMansions and Camps, all within a 35 minute drive from downtown New Orleans. Didactic images and juxtapositions are prevalent: oil and gas extraction jack-boats puncture the skyline like giant billboards and McMansions nestle up against old shotguns. This haphazard inclusive quality, resulting from the dynamism of the environment, has an effect similar to that described in LFLV of vitality and dynamism often absent in today’s planned communities.

2.15: STUDIO NOTES - § ENVIRONMENTAL VALUES AND ENVIRONMENTAL METHODS

(§ Commercial Values and Commercial Methods)

Through the research “we are trying to train ourselves to offer socially *relevant* skills.” (Venturi, Scott Brown, Izenour, 1977, 73)

PART 3: TYPICAL SUBURBAN ARCHITECTURE, OR SERVICE-ORIENTED ARCHITECTURE

(*Ugly and Ordinary Architecture, or the Decorated Shed*)...or, *the Manifesto*.

3.1.1: Some Definitions Using the Comparative Method

(ibid)

“To make the case for a new but old direction in architecture, we shall use some perhaps indiscreet comparisons to show what we are for and what we are against and ultimately to justify our own architecture.” (Venturi, Scott Brown, Izenour, 1977, 87) An architectural exploration of sustainability and resilience in the delta begins with research into traditional methods of coping with heat, wind and water in the built environment, essentially the passive strategies utilized before reliance on modern infrastructure that has proved to be increasingly fragile in this dynamic landscape. Sustainable and resilient architecture existed in abundance before large-scale engineered levee systems were erected beginning in the 1930’s and before fossil fuel driven environmental systems became the dominant form, as late as the 1960’s in Lafitte, LA. In order to achieve a truly sustainable architecture within an aggressively dynamic environment, the built form must be seen as inextricably linked to the natural processes in operation within space and time and the systems and services of the larger ecosystem, not traditional American resource intensive suburban development.

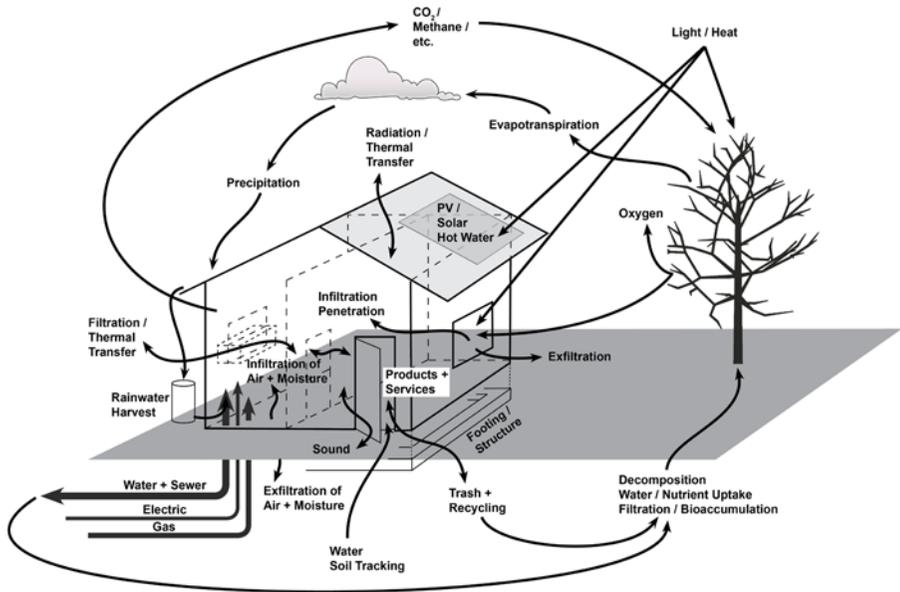


Figure 3: Built and natural environments behaving as one system. Adapted from: U.S. Department of Energy, Lawrence Berkeley Laboratory, <http://eetd.lbl.gov/ied/ERA/CalEx/partmatter.html> 2003 (Author, 2011)

3.1.2: Explicit and Implicit Associations

(ibid)

Explicit and implicit associations must be expressed architecturally as well as operationally. Communication is facilitated most completely in this manner “...it looks like what it is not only because of what it is but also because of what it reminds you of.” (Venturi, Scott Brown, Izenour, 1977, 93) Sustainable architectural form must operate both explicitly and implicitly in order to function adequately within its context. Ironically, the operational vernacular architecture of the delta has utilized this strategy to a great extent prior to the more recent domination of Mid-Century American Suburban Sprawl. Solutions to ventilation (verandas and apertures) and flooding (piles) often look like their operation, in addition to operating, and therefore remind and reference their operation. “These meanings come from our knowledge of technology...from the vocabulary of [vernacular] architecture, and from other sources.” (Venturi, Scott Brown, Izenour, 1977, 93)

3.1.2: Research Actions within the Design Studio

(How to Efficiently yet Meaningfully Engage Architects in the Frameworks of Unfamiliar Disciplines)

In the fall term of the 4th year, undergraduate professional degree students are instructed to understand the landscape and community of Lafitte. Through observation and design of modes of observation, mapping current conditions and dynamic relationships, and in building instruments for understanding processes and change within Lafitte, the students amassed the raw data needed to engage the design process. Next, through five phases of work:

- developing a *common language* based in landscape ecology principles: drawing and data collection
- documenting and *engaging* site and community

- defining site and *reflecting* on strategies: innovative modes of representation/ communication and temporal patterns
- *reengaging* research, reformatting and installing exhibitions on and off-site
- *proposing* a site specific systemic intervention within the town, and ultimately presenting it to the town (Chang, 2010)

As a service learning studio, the students directly engage both the inhabited landscape and stakeholder groups, ultimately investigating architectural representation of dynamic conditions, and examining the role of the landscape and geography in developing architectural strategies. The end of the term resulted in a strategic proposal presented to the Mayor and City Council.

Though this initial foray into the trans-disciplinary realm of research and production proved challenging for the students, and at times frustrating for the instructor because the quality of the architectural work was scattered and inconsistent, it clearly resulted in a much deeper understanding of and engagement with the geography and community than a typical research studio.

The resultant research studio product will take the emergent form of a zine to be produced and distributed freely to the community of Lafitte, the Southern Deltaic Louisiana, Academia and the Architectural Profession. The publication will disseminate select studio work along with faculty and CSS participant observations in order to facilitate a continuing dialogue (feedback loop) within the larger cultural context of the geography and related academic and stakeholder communities.

Because the research time-frame is a year at minimum, with the possibility of extending to 3 plus years, the evolving and expanding place-based knowledge and relationships are advancing in three simultaneous modes: a 2nd year graduate professional degree research studio, additional zine publication, and independent scholarly research conducted through the CSS.

We learned from phase one that the scientists were not engaged enough in the process, so the question becomes... how do we engage them more? An answer came through Environmental Systems Science... “[a]nd in a view of architectural education that embraced the complete art of environmental management, a visit to La Vegas would be as mandatory as a visit to the Baths of Caracalla or La Sainte Chapelle.” (Stierli, 2008, 19)

In the spring term, the 2nd year graduate professional degree students take on Lafitte through the lens of Environmental Systems as a mechanism to expand architectural design paradigms by further integrating the sciences into the design process. Through an examination of the ecological, cultural and environmental control landscapes of Lafitte, they will ultimately make proposals driven by service oriented design. The first half of the 2011 spring term has been dedicated to redefining Lafitte’s spaces at three scales: body, landscape and architecture (in that order), to facilitate innovative interventions into this geography increasingly resistant to human habitation.

This studio knowledge base is utilized to interpret and build upon the Undergraduate Studio’s observations while engaging the resources of the CSS in a more aggressive manner.

PART 4: APPENDIX – ON COMMUNITY ENGAGEMENT AND POLITICAL WILL

(On Design Review Boards and Fine Arts Commissions)

LFLV confronts Design Review Boards and the legal system’s lack of ability to appropriately qualify urban amenity and aesthetic. We need to expand the political arena of architecture in this circumstance to a more functional role, of providing services that help to mitigate and adapt to increasingly dramatic land-water interfaces. The PPD Framework includes “Policy” as one of the Social template behaviors, facilitating policy change. The ultimate goal is to actualize productive, service-oriented change through built/natural systems. Ultimately, political will is necessary to make any more than the most localized and small scale interventions in the system. But how, as architects and designers, are they engaged?

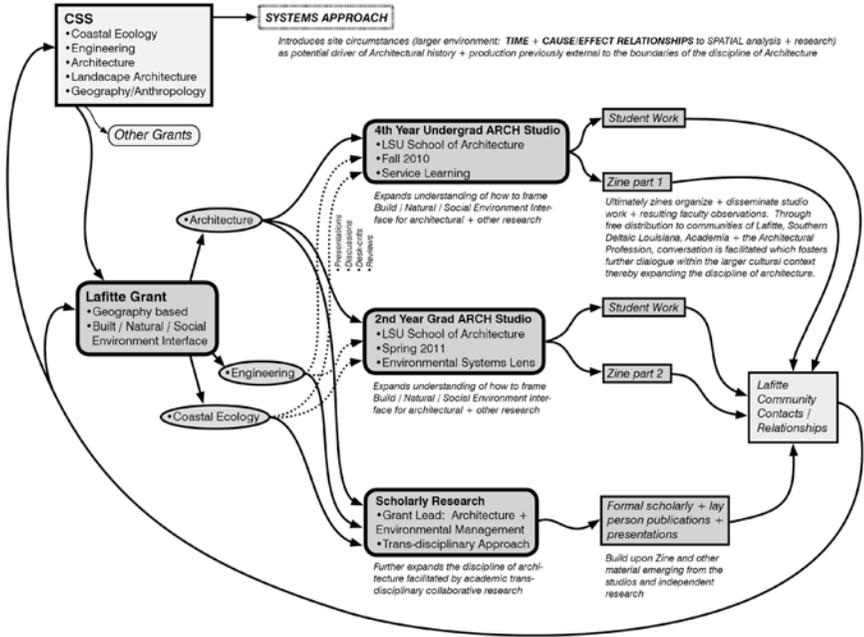


Figure 4: Structure of the research studio stack within the Coastal Sustainability Studio (Author, 2011)

The Zine, with its innovative visual and communication formats, has potential to engage community and elicit involvement. “Denise Scott Brown has pointed out that the specific use of imagery must also be seen in the context of advocacy planning...” (Stierli, 2008, 14) We are currently experimenting extensively with the relationship between content and visual form in order to engage as large an audience as possible in as meaningful way as possible.

CONCLUSION: A RETURN TO LFLV PART 2

Which Technological Revolution?

(ibid)

LFLV defined a new generation of architectural research, but without the inclusion of rigorous scientific input, its analysis of the environment was limited.

“The most urgent technological problem facing us is the humane meshing of advanced scientific and technical systems [and ecosystem services] with our imperfect and exploited human systems, a problem worthy of the best attention of architecture’s scientific ideologues and visionaries.” (Venturi, Scott Brown, Izenour, 1977, 151)

Today, through the support of the National Science Foundation, coupled human-natural models are increasingly being developed. These models can facilitate our recognition of the feedback relationships that exist between socio-cultural and ecological systems that operate on the surface of the planet. This recognition, and developing understanding of how to design architecture within these systems, is increasingly critical within the context of climate change and its projected impacts. Because the PPD framework is particularly suited to integrating the built environment and architectural design and research, methodologies for its use by architects must be developed.

Through the use of this framework in architectural design and research, and in conjunction with the resources of the trans-disciplinary Coastal Sustainability Studio at Louisiana State University, architectural research is beginning the process of clarifying its position in relation to the environment

and the larger issues of sustainability and resiliency. Architecture itself is an inter-disciplinary discipline, and therefore tends to attract people with multiple skill sets and integrative minds. Tackling sustainability and resiliency within the complexity of our increasingly global world requires the development and execution of productive working relationships between designers and specialists in other disciplines. A productive framework through which those relationships can be facilitated and ultimately that sustainable and resilient architecture can be produced is critical to our future on the planet.

ACKNOWLEDGEMENT

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Digital Steam Bending: Re-Casting Historical Craft Through Digital Techniques

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ABSTRACT:

Digital Steam bending is a design and fabrication research project that investigates the historically relevant, regionally significant technique of steam bending using advanced parametric software modelling, structural analysis and CNC (Computer Numerical Control) fabrication methods to reinvision the nearly forgotten technique of wood steam bending developed by Michael Thonet in the 19th Century. In doing so, Digital Steam Bending performs several operations: it reclaims a forgotten technique of fabrication and reframes it through the lens of contemporary digital craft, it claims new ground in the traditional periphery of architectural practice through shifting scales, and it confronts the difficulties of digital design and digital form generation through applied material practices. It also gestures toward the possibilities that regional resources and craft may leverage against high-carbon globalized manufacturing.

Digital Steam Bending was conducted as a series of interconnected feedback loops in which material resistance, formal manipulation and digital tools were each allowed to influence the others. Material testing on various wood species began simultaneously with the development of formal digital models, where built up aggregations of unique but similar individual parts were digitally assembled, modified and reassembled to derive possible means of tectonic connection and overall form in search of spatial, architecturally scaled assemblies and structures. Locally harvested, FSC Certified, air-dried White Oak, evolved as the optimal material due to its high density, consistency of grain, natural durability and local abundance. Several base components were designed, tested and refined before ultimately arriving at full scale fabrication. The assemblies were then installed and documented as an exhibition at the University of Michigan's Taubman Gallery and as full-scale gateway structure at Fredrik Meijer Gardens in Grand Rapids, Michigan during Art Prize 2010.

ON APPROACHES: digital approaches and the 'real world', sustainability, alternative research methods
KEY WORDS: Thonet, steam bending, parametric, biodegradable, fabrication, testing.



Figure 1: Steam bent snowshoe, a No. 14 Café Chair and the Thonet label

INTRODUCTION

The thrust of this paper is to use Digital Steam Bending to posit a number of open-ended questions and claims that call into question current trends in architectural practice and academia. Specifically, this paper challenges the discipline's tendency to ignore historical methods of craft and fabrication and to assert digital design without context or material considerations. These questions emerged as a

result of work conducted under a grant through the University of Michigan, aptly named Research Through Making. Inspired by the elegance and the unique history of the Thonet No. 14 Café Chair (Figure 1), we began asking ourselves, can we as architects and designers find fertile ground in revisiting methods of fabrication which were once successful, but were ultimately abandoned in the drive toward modernity? It seemed to us that strategies for fabrication which predated electrification and the development of the global industrial complex, provided opportunities to engage architectural modes of thinking and making that are rich with historical significance, that connect us to the local environment, and that provide avenues for design thinking in truly sustainable ways. The availability of digital computational resources and tooling, with their ensuing biases and sometimes problematic tendencies within the discipline and practice of architecture, could then be set at both collaborative and cross purposes to applied material research.

The success of the Thonet No. 14 Café Chair is difficult to overestimate. But, at the heart of Michael Thonet's success were significant advancements in techniques for forming solid wood members using steam heat, rigid formworks, and steel tension straps to shape wood members, i.e. "steam bending". Steam bending is a pre-industrial fabrication process which was used extensively in the Great Lakes Region of the United States as a traditional method for fabricating canoes, snowshoes, barrels and even early automotive components. Steam bending subjects a piece of air-dried lumber to steam heat and moisture, thus momentarily softening its fibers and enabling it to be bent in multiple directions and to such a degree as would be prohibited by cool, dry timber. Steam bending allowed the over-shaping of the material thus producing "a secondary natural aesthetic" (Gleiniger 1998, 40), but early uses, dating back to the late 1700's were technologically underdeveloped and aimed almost exclusively at functional uses. The shipbuilding industry was an early adopter of this technique for forming the complex, curving members used to build ship's hulls. However, the technique was most often deployed for one-off form fitting applications during the framing and "planking up" processes for the hulls of wooden boats. The necessity of use was less an intentional design choice so much as a stop gap measure driven by the high cost and scarcity of durable metal fasteners which were required to force compliance in the ship's timbers. In the United States, during the 1840's and 1850's inventor Thomas Blanchard and shipbuilder John W. Griffiths both promoted the use of adaptable steam bending machines but met with only mild success due to high cost and economic trends pushing the shipbuilding industry toward steel manufacturing (Thiesen 2006).

In Europe, Michael Thonet significantly developed the steam bending process for furniture making, effectively taking it from a custom technique used only by highly skilled craftsmen to a mechanized and refined industrial process. On July 10th, 1856 Michael Thonet received a patent from the emperor of the Austro-Hungarian Empire to produce chair and table legs from steam-bent wood (Wilk 1980).

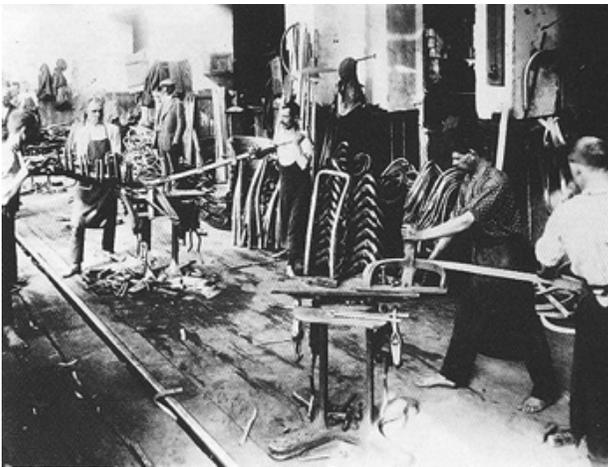


Figure 2: Barefoot workers at a Thonet factory. Source: (Vogesack 1997)

Thonet's patent was the culmination of more than a quarter century of material and process research in the fabrication of steam-bent solid wood members. Prior to that Thonet worked extensively with layered wood veneers and glued wood composites. Early techniques were extremely labor and material intensive. Due to the lack of sufficiently durable adhesives, previous techniques failed to move beyond the realm of super-custom, one-off furniture.

Thonet's developments in wood steam bending ultimately gave rise to an entire line of bent wood furniture, the most iconic of which is the Café Chair No. 14, often referred to simply as the "Thonet Chair". In 1857, Thonet opened his factory in Koritschan; the factory works there were dedicated almost entirely to the production of No. 14 Chairs. Within three years of commencing production, the factory produced more than 50,000 pieces of furniture (Wilk 1980). By 1930, global sales of the No. 14 Chair had reached 50 million units (Gleiniger 1998). While the No. 14 Chair is recognizable in its design and elegant fabrication, it is also one of the most recognizable symbols of mechanized industrialization.

The Koritschan factory opened in 1857, and with it Thonet's production of furniture moved completely out of the realm of craft into industrial production. For the first time no craftsmen or cabinetmakers were employed. The local workers were trained in the completely new methods of industrial production, which stressed the importance of timing and the necessity of teamwork (Wilk 1980, 23).

Figure 2, depicts conditions in one of Thonet's factories during the turn of the century. Large numbers of low-wage workers (shown in bare feet) were responsible for the production of most of Thonet's furniture. Regionally, steam bending was often used in the fabrication of shipping vessels, but the technique was also employed in other capacities. The mid-west region of the United States was uniquely rich in raw materials and at the cross roads of the modern industrial movement. In Michigan, carriage manufacturers were the predecessors to the automobile industry. The production of horse drawn carriages frequently involved the use of steam bending to produce laminated wheels and portions of the carriage frames. Moreover, during the 1890's the Midwest region proliferated with small automobile start-ups, and later, the Detroit area became the seat of the United States automobile production.

Since the peak of production in the early 1900's, steam bending has become virtually obsolete and, the demand for steam bent furniture products and wooden ships dropped precipitously during the 1920's and 1930's. The availability of a sufficient quantity and quality of old-growth timber declined drastically due in large part to poor resource management and global demand for timber. Additionally, increasing labor costs coupled with new material developments caused the furniture industry to jettison steam bending for newer more modern materials and processes. Steel quickly replaced wood as a more expedient (and modern) material for construction and fabrication. Steel was readily available; it was also durable, and most importantly, the techniques for fabricating with steel yielded highly predictable, consistent results. Steel virtually eliminated material resistance from the process of fabrication thus allowing an even greater step away from the necessity of craft and skill in making. As the demand for steam-bent wood products declined, the skill to produce such items was all but lost. By the late 1920's even Thonet manufactured chairs out of chromed tubular steel.

Further advancements in chemistry also played a role with steel to seal the fate of steam bending. Prior to the early 1900's, adhesives for wood lacked sufficient quality and durability, keeping the plywood industry at bay. Animal based glues were expensive, difficult to manufacture and could not withstand exposure to humid environments. Subsequent casein and blood-albumin glues were equally expensive and energy intensive, but once cured yielded water insoluble bonds (Pizzi 1989). In 1912 Leo Baekeland, chemist and inventor of the phenolic resin Bakelite, suggested the use of his synthetic resin in forming plywood. Baekeland's adhesive resin yielded an extremely strong, durable and virtually impervious bond. It could be easily formed into sheets or applied as a liquid between veneers of wood (Ngo 2003). The demand for veneer-ply boats hulls and aircraft parts during the war years propelled plywood to domination in the wood industry and drove the final coffin nail into the steam bending industry (Figure 3). Most notably, Charles and Ray Eames' developed many of the benchmark articles of wood veneer products which epitomized the modern lifestyle of the 20th Century. Although plywood products use many of the same techniques that steam bending uses, including bending jigs, fixtures and heat, they also by necessity, use adhesives in relatively large quantities which often have pernicious chemical byproducts and can be unfit for human contact.



Figure 3: 1944 Fortune magazine advertisement Source: (Ngo 2003)

I.1. MATERIAL(S) OF CHOICE

Presently, locally produced, locally harvested and renewable materials represent one way in which we can reduce demand for energy intensive, non-renewable resources. In the 21st Century, research and discourse with design fields is increasingly focused on dealing with the environmental impact from many years of expedient production. The energy cost and carbon footprint of products made from plastics and metals—especially those whose origins or ingredients travel thousands of miles before reaching the point of consumption—are extremely high. Further environmental costs are incurred when non-biodegradable materials enter the waste stream. Steam bent, all wood structures are completely biodegradable. And, steam bending allows complex formal geometry to be achieved without the use of adhesives or plastic or metal fasteners. Steam bending can be accomplished with a minimum of energy input and it requires no toxic chemicals or adhesives. Choosing locally produced, locally harvested materials as the basis for focusing research allows design thinking and architectural discourse to encompass vernacular material roots and historical precedent while leaving open the possibility for engagement with contemporary architectural practices.

The most conducive materials for steam bending are those which are the least refined by industrial processing. Since steam bending requires lumber with high moisture content, less processed, air dried material is superior in performance to its kiln dried relative. The water naturally contained in the cells of the wood works to keep the fibers supple during bending and also acts as a flux, aiding the transfer of heat from the steam chamber to the section's center. Rough sawn, air dried lumber has a typical moisture content ranging from about 8-19 percent while kiln dried hardwood lumber is typically brought down to about 4-5 percent moisture content by weight before ultimately being rehydrated to around 8 percent (Allen, 2009).

Prior to entering the steam chamber, the wood is soaked in a bath of plain water for a period of approximately 36 hours to bring the timber sections up to about 25-30 percent moisture content by weight, or, as near as possible to the fiber saturation point. Once the timbers are sufficiently hydrated, they may be removed from the soaking bath and placed in a steam tube. The amount of time spent in the tube is determined by species, initial moisture content, and thickness of section. Once the material is fully heated, it is removed from the steam chamber and quickly transitioned into one of several adjustable fixtures (Figure 4) to be manipulated into the desired form. The use of pre-fabricated chords and spreaders (Figure 5) together act as a mobile drying fixture while the formed pieces cool and subsequently air dry.



Figure 4: Variable jig with a steam bent wishbone



Figure 5: Formed, braced ribs drying

1.2 FROM THE PERIPHERY

Traditionally, steam bent wood work was an afterthought to the primary production of architectural space. Bent wood trim and furnishings when used, were often chosen as an analogy to other malleable materials like iron or plaster. Architectural case studies of steam bent wood are difficult to find. Thonet's contemporaries Henry Van De Velde, Victor Horta and Hans Wagner occasionally used steam bent wood trim in their interiors, but the applications only aspired to a supportive role as small scale accoutrements to the essential tectonics of construction and the execution of architectural space. Even today, material and tooling limitations primarily dictate the scale of individual pieces of steam bent wood, but the use of digital parametric tools aid in shifting from the scale of furniture up to an integrated architecturally-scaled construct with a coherent structural system. In our research, we have endeavored to understand our design process as one in which the overall fluid expression of a malleable whole is the aggregation of large numbers of unique small-scale components. This is not a new idea, but it is particularly the skilled deployment of digital parametric models which allow a complex assembly of parts and an historical fabrication method together to produce an integrated whole with unique dimensions and geometries under the control of the designer. In these assemblies, each individual component is linked to the next through a set of logic and geometric relationships. Through refinement and evolution of our work we are able to position the whole as an integrated system of structural sub-assemblies the result of which is a significant shift up in scale that gives steam bending currency at the level of architectural structure.

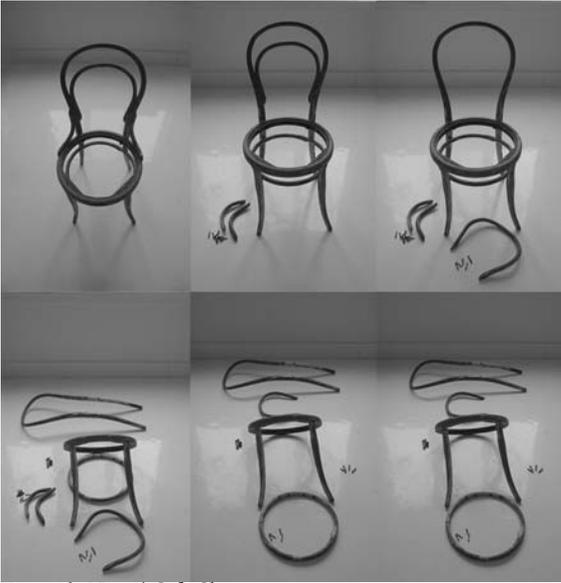


Figure 6: No. 14 Café Chair

1.3 THE DNA

Much of the Thonet furniture line was available as “knock-down” pieces, more than a century before IKEA. The No. 14 Chair required only a handful of individual parts which, could be densely packaged for shipping and then assembled after reaching their final destination (Figure 6). By resolving the chair into a small number of rational, standardized components, an entire line of furniture was able to share many parts and tooling. This simple idea promoted the refinement of the process and the standardization of parts to a degree that had previously only been imagined. Streamlining the operation enabled consumers to access a wider variety of affordable choices. But it also meant that the spectrum of individual choices was discretized and therefore many formal outcomes which could be rendered through steam bending were precluded.

1.4 STEINER ELLIPSES

Inspired by the graceful, high-arching seatback of Thonet’s No. 14 Café Chair we began our research by exploring aggregations of wooden loops—bent first in one direction then in two. We developed digital and physical models as well as a series of adaptable formworks for producing ellipses which were then grouped and aggregated to compose tetrahedral space frames based on Steiner Ellipses (Figure 7).

This was a simpler, first model in which we explored the range of material capabilities and refined the parameters for material processing. It provided a basis for bringing the material failures (Figure 8) into communication with a set of digital parameters which could then be modified to predict the feasibility of other constructs. Each module of a larger framework is based on dynamic clusters of four Steiner ellipses.

The framework’s structure is highly adaptable to different symmetrical and asymmetrical conditions and applications. Although it’s fluid and adaptable nature holds promise for formal operations, it’s intensive requirements for tectonic fastening and material limitations sidelined it as a primary strategy for rendering robust structure at an architectural scale. Because the circumferential distance of a modestly sized ellipse began to exceed the reasonable availability of material and tooling strategies, the development of large scale constructs was at odds with our desire to explore structurally and materially efficient models for engagement at scales larger than that of typical furniture (Figure 9).

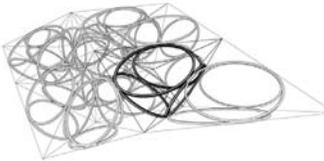
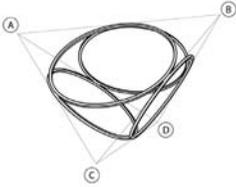
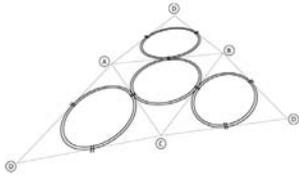


Figure 7: Steiner Ellipse building blocks



Figure 8: Material failures

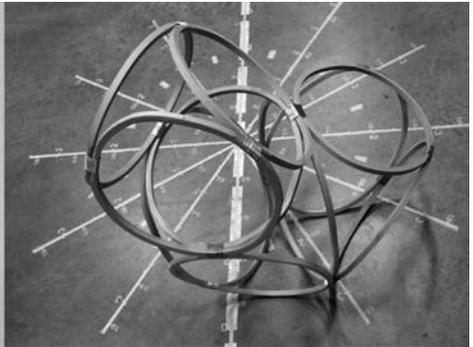
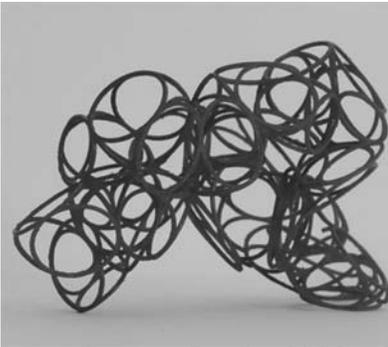


Figure 9: Spaceframe elliptical model (left) & full-scale construct (right)

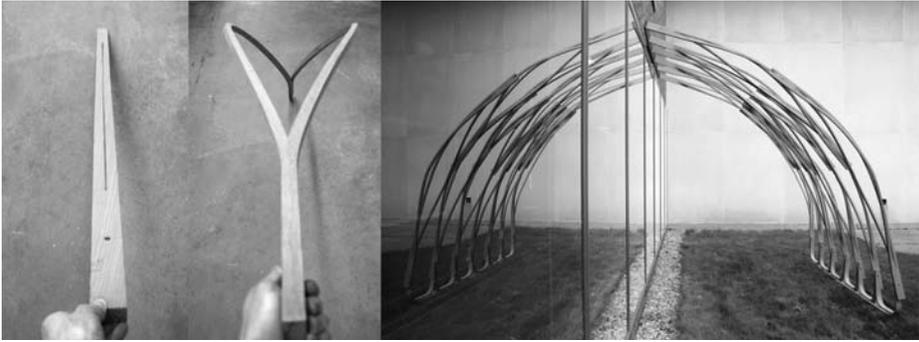


Figure 10: Split blank, formed rib and aggregated arch structure.

1.4 THE BONES

In further research, we developed a second structural component, a rib or “wishbone” (Figure 10). This development came as we were processing the results from several space frame prototypes. While we had developed a means for manipulating material and modeling behavior, we were limited in scale by the ellipse’s geometry and structural tendency to deform unpredictably as the scale of assembly increased. The early process of milling the raw material into square blanks for bending ellipses we realized, could be manipulated through digital tooling (in this case a CNC waterjet cutter) to open up another range of forms and processes which ultimately yielded greater success. Similar to the ellipse construct, formal strategies and material assemblies were explored through digital modeling and physical testing. Through a series of parametric manipulations and computational optimization, we produced a schedule of parts which specifies the precise dimensions and orientation of each unique part. A digital cutsheet then enables the translation between model, material and tool. The prepared blanks are tagged with a serial number indicating the part’s position relative to the whole. Our method for forming the pieces is similar to those used in the shipbuilding industry in that it does not require a tension strap, but it makes a significant departure from previous methods with the use of a variable jig. As the blank is compressed, the sides of the wood member spread outward and bow upward. The resulting components may then be assembled into a thickened sheet-like lattice. The ribs yield a variety of inherent construction logics based on nodal connection points which form a robust, flexible structure. The expression of form is directly related to the process of fabrication and the underlying geometry of the part. The degree of bend ultimately achievable through this process of fabrication is limited by a threshold for material failure; most of the components within the structure are formed near the limit. Some components are imparted with lesser degrees of camber and spread to increase variation and sculpt the natural tendency toward arch structures.

1.5 NATURAL SELECTION: MATERIAL RESISTANCE AS DESIGN GENERATOR

The specificity of Thonet’s cast iron jigs prescribe a process aimed at forcing an unpredictable material such as wood to submit to a standardized form (Figure 11). The history of Thonet’s success is illustrative of the historical trend for craft to be focused either on the production of one-off, labor intensive constructs, or for the refinement of consistently reproducible copies. For Thonet consistent parts were vital to production. The forms themselves were complex but could be produced by unskilled labor. Thonet’s advancements in industrial processing did indeed yield many long lasting and remarkably consistent pieces but, the process also involved enormous quantities of waste and failure. Requiring an unstable and often low-precision material to conform to tight standards meant that adaptability through open systems of feedback was not an option.

Our method of research through making on the other hand, describes an open process of evolution in which systems for thinking, seeing, and making all remain in dialogue with each other, connected by material constraints and tooling biases. By not positioning the endgame as the achievement of a fully developed construct in compliance with independent representational modes, unexpected consequences of making are allowed to influence, and ultimately richen the design. It was well known



Figure 11: Early Thonet cast iron mold. Source: (Vongesack, 1997)

to us that wood, especially white oak will ebonize when placed in contact with chemicals (including plain water) that accelerate the process of oxidation. Our choice of tooling, in this case a CNC waterjet cutter, that was used to administer the custom slices to the wood blanks, caused a drastic, localized blackening of the wood fibers due to iron oxide in the waterjet's supply tank from many previous hours of steel processing. Rather than abandon the CNC slicing for another analogous process, we made the choice to fully ebonize the material prior to bending by soaking the pieces in excess water from the tank. The result was a full, even blackening of the wood fibers which, when taken in the context of site and composition, yielded a strikingly serene and quiet formality to the bold colors of a garden in bloom (Figure 13). In hindsight, the acceptance of the biases of tooling and materials led to the understanding and exploitation of a completely natural, non-toxic realization of one of the most important features of the project.

1.6 EVOLUTION: QUESTIONING THE JIG

Much of our research and continued methodology is focused on situating “physical” knowledge in digital environments. Embedding material behavior and tacit knowledge acquired through direct physical contact with material and process allows us to bring digital spaces into closer analogy with the physical ones they represent (Figure 12). Thus, material limitations and failures become significant form generators and informants to our digital models. The build-up of physical knowledge enables a flexible and often accurate way of extrapolating digital output to the physical world. However, it is by no means an absolute connection and thus the feedback moves both ways. In that sense, digital development runs a parallel track with physical making. It allows us to accept the deviations and the inherent imprecision of natural, idiosyncratic materials.

It is often the case that physical making is one step ahead of the capability of the digital model to reflect the ability of materials to assume new form or provide certain structural characteristics. Movement forward is a balancing act of reciprocity and speculation between the digital and the physical.

In contemporary architectural practice, academia and within the discourse surrounding each of these connected aspects of the discipline, it often becomes problematic to strike a balance between the allure of digitally crafted space and form and the ability of materials and structural systems to be resolved into a functioning architecture. Digital spaces tend toward designs that are conceived without substantial influence from material capabilities—they are the confluence of infinitely adaptable, malleable, compliant, homogenous, structural wonder materials. Typical materials which are exploited for similar characteristics, such as concrete and steel have large environmental footprints. Problematically, the discipline produces a large number of theoretical projects which are relegated to “paper” or else, the essential moments of the design are drastically watered down to accommodate structure and cost.

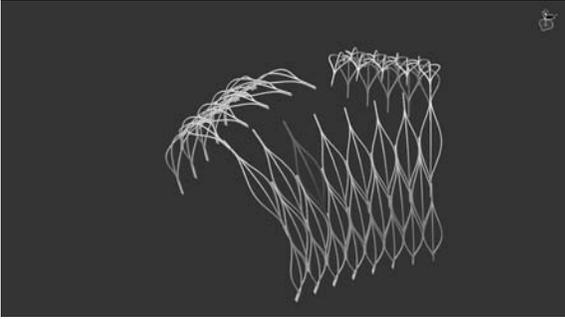


Figure 13: Full-scale gateway installed at Fredrik Meijer Gardens, Grand Rapids, MI. Source: (Beth Singer, 2010)

Our research gets traction by engaging alternative methods of design thinking through open dialogue between material, process and structure where each are balanced acts of architecture. It does so in two ways. First, by embedding material and construction logics within digital models, the outcome(s) of successive evolutions in digital environments converge along sometimes widely disparate trajectories that nevertheless remain (mostly) within the realm of possibility. In fact, we may more easily occupy and thicken the threshold between possibility and impossibility and navigate this created boundary with alacrity. Secondly, by embedding material characteristics and tectonic logics into the parametric model, the model becomes both fuzzy and precise. That is, the model becomes capable of dealing with traditionally difficult characteristics such as elasticity and material spring back, while keeping precise track of a detailed set of instructions that can be communicated to CNC machinery, or translated into unique form. We allow ourselves through play with and within digital spaces to release a degree of control in order to uncover or invent unique configurations of material, light and form. The feedback loops which drive the development of the model are ones in which material is tested, formed and often taken through the point of failure. We are able to translate knowledge and measurement of the empirical world into increasingly sophisticated and robust digital parametrics, or rules of engagement which liberate us to explore beyond the scope of limited human piece-wise design strategies. It cannot often be fully determined what range of outcomes will result from the

simultaneous interactions between complex parameters. Thus, the model is itself a digital jig of sorts, which can be placed in the service of the designer as a collaborator for finding what we refer to as ‘beautiful monsters’.

Thonet’s jigs were templates of the parts. However, in our research, as in our digital models, each piece is unique, and thus the armatures for production must allow for the complete range of flexibility built into the digital model. In this sense our jigs are more an instrument to be played, than an exact and fixed formwork.

1.7 NOTES ON ASSEMBLY

When the means and action of fabrication are divorced from the process of design (a particular risk of closed digital systems) aspects of the actual construction and assembly processes are placed at risk of terminating or at least compromising the integrity or intent of the design. Digital tools offer ways of seeing and envisioning design strategies, but they can also promote inattention to the processes required to realize full-scale work.

In our case, the entirety of the arch structure was developed alongside an additional but invisible set of construction formworks that enabled the mutable and complex aggregation of components to be physically joined (Figure 14).

The nature of the process is one of coordination and constant recognition of the structural tendencies and resilience of the incomplete structure and sub-assemblies. Within our research and fabrication it is only at this point of the process when it becomes necessary to establish a rigid formwork or scaffolding (Figure 15) in order to move between the gravity free virtual world, real materials and space.



Figure 14: CNC cut fabrication forms

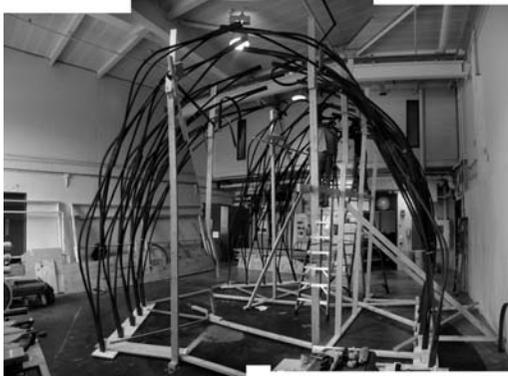


Figure 15: Full-scale construct under fabrication

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Research in crisis: new analytical tools for the humanitarian architect

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ABSTRACT:

In the preface to *Design Like you Give a Damn*, the much-publicized catalogue of humanitarian design edited by Architecture for Humanity, author Kate Stohr charts “100 years of humanitarian design”, starting with the government-sponsored sheds built after the 1906 San Francisco earthquake and concluding with the dozens of humanitarian projects featured in the volume itself. In the process, Stohr highlights a troubling trend. From the well-documented failures of early modernist housing to the minimal range of current work by Rural Studios and others, Stohr’s survey of over 100 years humanitarian design contains few, if any, projects that have successfully empowered, invigorated, or unified communities in the long-term.

Although designers are quite divided as to the reasons for this checkered history, recent work within the field of development communication might suggest a cause. Historically, the practices of development communication, like those of humanitarian design, have been based upon a diffusion model of practice. In this model, the chief purpose of a development campaign is to provide information that will persuade individuals to change their behavior for the good of many. For myriad reasons, this model failed to work. In response, communication experts developed the participatory model, a practice that trades the top-down processes of information transfer for techniques that promote a continual exchange of information between the players in the project. In the participatory model, the practitioner works with community members to continually reassess their needs and collaboratively design methods to address them.

This paper will use the participatory models of development communication to evaluate current practices of the humanitarian designer. As a framework, this writing will accept two methods of assessment: the work of Dr. Jacobson, who has adapted the principles of Jurgen Habermas to offer a new model of evaluation for participatory projects and the post-occupancy evaluation model commonly deployed by architects. From this evaluation, this writing will propose several techniques of pre- and post-occupancy research and evaluation for the humanitarian architect.

CONFERENCE THEME: On Approaches

KEY WORDS: “humanitarian design”, “development communication”, “participatory development communication”, “post-occupancy evaluation”, “participatory design”

INTRODUCTION

Development communication is “the strategic application of communication technologies and processes to promote social change” (Wilkins, 2000, p. 197). It is a movement founded upon the conviction that strategic communication can impact behavioral patterns, aid development projects and, thus, improve health, education, agriculture, and other matters of great concern around the globe.

Humanitarian design is the strategic application of art, architecture and other creative work to address urgent needs around the world. It is a movement founded upon a belief in design’s potential to “empower, invigorate, and unify communities” and impact health, education, and other matters of great concern around the globe (Wilson, 2007, p. 29-31).

Unfortunately, the convictions of both movements have yet to be verified.

In the preface to *Design Like you Give a Damn*, the much-publicized catalogue of humanitarian design edited by Architecture for Humanity, author Kate Stohr charts “100 years of humanitarian design”, starting with the government-sponsored sheds built after the 1906 San Francisco earthquake and concluding with the dozens of humanitarian projects featured in the volume itself. In the process, Stohr highlights a troubling trend. From the well-documented failures of early modernist housing to the minimal useful range of current work by Rural Studios and others, Stohr’s survey contains few, if any, projects that have successfully empowered, invigorated, or unified communities in the long-term.

Although designers are quite divided as to the reasons for this checkered history, recent work within the field of development communication might suggest a cause. Historically, the practices of development communication, like those of humanitarian design, have been based upon a diffusion model of practice. In this model, the chief purpose of a development campaign is to provide information that will persuade individuals to change their behavior for the good of many (Rogers, 1962). For proponents of diffusive models of practice, development was about transferring information from those in the know to those who were not. After all, as it is written: give someone a fish and you feed them for a day; teach someone to fish and you feed them for a lifetime.

Unfortunately, the knowledge transferred through this top-down method of development communication failed to take root within the populations they were intending to serve. Those receiving said wisdom felt that the innovations did not belong to them, that they were the passive receivers of knowledge, not the creators of it. Thus, when something went wrong, they felt powerless to evolve the ideas to meet new conditions, instead expecting the initiators of the innovations to provide a fix. In response, mass media and communication experts developed the participatory model, a practice that trades the top-down processes of information transmission for techniques that promote a continual exchange of information between the various players in the project. (Waisbord, 2000, p. 17) In the participatory model, the practitioner works with community members to consistently reassess their needs and design methods to address them (Morris, 2002).

COMMUNICATIVE ACTION: THE ROOTS OF PARTICIPATORY DIALOGUE

In 1970, Brazilian educator Paulo Freire (1970) postulated that the central goal of communication is not persuasion, but “conscientization” - a free dialogue that prioritizes cultural identity, trust and commitment. (Freire, 1970) In Friere’s mind, communication should provide all parties with a sense of ownership over the ideas explored – a call that describes well the goal of most participatory models of development communication. Around the same time, planners and architects, inspired by writers like Jane Jacobs (*Death and Life of Great American Cities*, 1961), Rachel Carson (*Silent Spring*, 1962), and Robert Venturi (*Complexity and Contradiction in Architecture*, 1966), were attempting to replace modernist, top-down planning practices with more community-centered approaches. (Schuman, 2005) Unfortunately for those in development communication, planning and design, Friere’s free dialogue has proven quite difficult to achieve. Thus, while some projects have achieved a fairly high level of success using the principles espoused by proponents of participatory planning and development communication, creating collaboratively generated, locally rooted and sustainable projects of fair utility, most have failed to reach even the modest level of success realized by their diffusive predecessors.

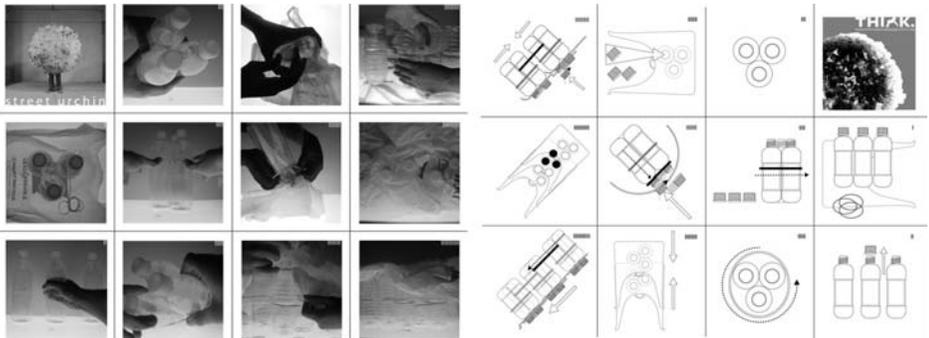
To build off the successes of the former and address the weaknesses of the latter, writer and educator Tom Jacobson (Jacobson, 2010) proposes an evaluative framework capable of assessing the dialogic variables that make participatory development possible. As a foundation for this work, Jacobson uses the seven elements of communicative action proposed by sociologist Jurgen Habermas. For Jacobson, Habermas’s theory of communicative action, which proposes an undistorted, non-ideological communication structure (originally designed to provide a basis for confronting systematically distorted communication), is inherently participatory.

The first four principles offered by Habermas - *validity claims* – all focus upon the assumptions that make action oriented toward understanding, which Jacobson refers to as “participatory dialogue”, possible. According to Habermas’s theory, individuals exchange speech acts because they believe said

acts are: (a) true, (b) normatively appropriate, (c) sincere, and (d) comprehensible. Without these four conditions, effective communication is not likely. After all, it is quite difficult for someone who is constantly concerned that he/she is being insulted to engage in valid speech acts. It is equally difficult to do so if one is confronted with insincere or incomprehensible language. This is not to say that all acts of communication fulfill all four categories. Rather, it is to identify those expectations that make communication possible. When met, said expectations operate in an unconscious way; when breached, for example, when one believes they are being lied to, they are made conscious. Either way, in Habermas's view, they furnish the substructure of communication.



Image series 1 streetURCHIN uses simple, repetitive techniques to create a completely watertight and easily transported urban tent from nothing more than discarded plastic shopping bags, rubber bands, and used water bottles. Although many streetURCHINS have been constructed, the chief manner of disseminating this work is an image-based and pocket-sized manual that describes the twelve-step construction process. Hundreds of these manuals have been distributed in galleries in the US, Poland and various online venues, creating an open-source platform has created new forms and better designs. [images courtesy International Design Clinic, www.internationaldesignclinic.org]



The second three principles offered by Habermas - *speech conditions* - outline the circumstances necessary to entertain more complex dialogues. The first condition is intended to ensure freedom of expression and is founded upon the ability to “express any attitudes, wishes or needs”, to “introduce any proposal”, and to “call into question any proposal”. The second condition, which Habermas identifies as the “symmetrical distribution of opportunities to contribute”, speaks to the necessarily egalitarian nature of the ensuing dialogue. The third condition offered by Habermas speaks to the mechanisms used to judge the points raised, privileging the determination of outcomes through the “force of a better argument”.

Taken with the validity claims cited above, these three conditions describe well the expectations necessary for effective communication. It also describes why the top-down methods proposed by diffusive models have failed to provide the desired results (Morris, 2003). After all, it is quite difficult to have a symmetrical distribution of opportunities to contribute when the conversation is framed in a manner that privileges the insight of one party (those offering the wisdom) over another (those receiving said wisdom). Given the alignment between Habermas’s seven principles of effective communication and the stated goals of both participatory (development communication) and community-centered (planning) models of practice, it seems reasonable to agree with Dr. Jacobson when he argues that Habermas’s conditions can be used as an evaluative frame. Through surveys, questionnaires and interviews, participants could share if they believed the organizing agency to be knowledgeable about local conditions (truth), whether or not the staff behaved in an appropriate to the local culture (appropriateness) and to what extent the participants understood the proceedings (comprehension). They could also share if they felt free to raise proposals (free to raise any propositions) and whether or not their viewpoint was treated equally (equal treatment of propositions). This data could then be compared to other existing metrics, such as citizen buy-in or the achievement of the goals held by the project itself (to provide a more hygienic environment, to get people to immunize, etc), to determine the impact of participatory processes in realizing successful work.

PARTICIPATORY PRACTICES IN ARCHITECTURE

In architecture, participatory practices have provided a fundamental manner of working for community-centered design practices, alternatively called socially-responsive design, humanitarian design, and design as activism. For the community-centered design practitioner, participatory practices are of critical importance in all phases of design, from conception to, and often including, construction. To date, the format of these practices is largely borrowed from similarly intentioned practices found within the larger field of architecture. Although aspects of all phases of design have been so incorporated, this paper will focus upon the two phases most commonly engaged to this end: post-occupancy evaluation and community-centered design charrettes.²

Wolfgang Preiser defines post-occupancy evaluation (POE) as a “means of collecting data on which to base future programs” (Preiser, 1993, 369). Edith Cherry describes POE as a manner of comparing “intentions of the architectural program to the resulting situation after the project has been in use for some time” in order to fine-tune the approach of new work based upon disconnect between existing building(s) and existing use(s). (Cherry, 1998, 89-90) POE methods, which range from highly formal to more casual, often include individual interviews, surveys, walk-throughs, report and study reviews, visits to other facilities and observational audits, are largely intended to document the interaction between the work and those who inhabit it, including not only the users, but also the general public. (Preiser, 1993, 380) Here, perhaps more than any other phase of design, the input of the public, expressed both explicitly, through interviews, surveys and questionnaires, and tacitly, through occupation of the work, is offered clearly and concisely, in a manner that would permit the wisdom of many to play a key role the design process.

The second method favored by many community-centered designers, the public charrette, is widely accepted as the primary vehicle for including public input in the design process. In fact, Cherry uses the public charrette almost synonymously with participatory practices. In terms of executing a public charrette, the first step is to obtain the owners permission to design in this manner. If approved, the designer requests that the owner select a building committee consisting of representatives from each of the major interest groups and determine the ultimate purpose of the group: to make design

decisions, to offer recommendations, or to simply highlight important issues. Finally, if deemed appropriate by the owner, mechanisms for including the insight of others who wish to impact the project are established. (Cherry, 1999, 54-6)

HIERARCHICAL CONVERSATIONS AND GROUPTHINK

It is important to note that neither of the mechanisms described above necessarily allow the public to have any real role in the work. In both post-occupancy evaluation and community reviews, the client remains the unquestioned authority, deciding whether or not to even include either mechanism in the design process and to what extent the findings uncovered will impact the work. Although the hierarchical relationships established through these client-centric processes are arguably appropriate when completing some works of architecture, they become quite problematic when utilized in more community-centered projects. For example, returning to Habermas's theory of communicative action, it is quite difficult to believe that the members of a committee formed under the conditions outlined above could possibly feel that their propositions would be treated equally to those offered by the client. Said doubts would likely call into question the sincerity of the meeting, greatly reducing the possibility that communicative action, or effective dialogue, would be possible.

Just as alarming, the owner-centric processes commonly deployed in community-centered work dramatically increase the probability that the people gathered in this manner will lack true diversity, potentially paving the way for *groupthink*. That is, any group hand-picked by a single person or body of people will necessarily be limited by the experiences of said person or group. This creates a strong leaning toward certain sectors of the public – a bias that is only intensified by the methods used to advertise the meetings held, all of which will also be necessarily limited to the forms of advertisement known by the client and their hired help. When combined with the difficulties of positioning this advertisement in a manner that will communicate relevance to a wide audience and gain the interest of all people impacted by the work, these leanings can have a huge impact on who decides to participate. Finally, the parameters of the meeting itself, in terms of time, place, and format have a tendency to similarly skew the participants. For example, holding a meeting at night may welcome those who work during the day, but will limit the participation of those with children, night jobs, or extra-curricular responsibilities. Similarly, holding the meeting in one part of town will bias the proceedings toward people who have easier access to the space; those with cars, along the bus route, or within walking distance, will be far more likely to attend than those who are located less conveniently.

These factors severely limit the diversity of the group – a fact that will significantly impact the ensuing conversation. According to James Surowiecki, author of *Wisdom of Crowds*: “homogeneous groups are great at doing what they do well, but they become progressively less able to investigate alternatives.” (Surowiecki, 2004, 31). Radical ideas or unpopular notions are quickly overlooked, regardless of their validity, in favor of those points or beliefs held by the majority. Popularity, not the soundness of argument prevails, creating *groupthink*: “the important thing about groupthink is that it works not so much by censoring dissent as by making dissent seem somehow improbable ... even if at first no consensus exists – only the appearance of one – the groups' sense of cohesiveness works to turn the appearance into reality, and in doing so helps dissolve whatever doubts members of the group might have.” (Surowiecki, 2004, 37) Over the course of the meeting, this false consensus steels the minds of the participants, closing them from ideas offered by the minority or overlooked by the group as a whole. Under such circumstances, ideological communication has effectively compromised the ability of the group to realize effective communicative action. (Surowiecki, 2004, 180)

THE ILLUSION OF THE EXPERT-ARCHITECT

According to experts in the field of participatory design processes, it is the responsibility of the facilitator to ensure that the conversation is run in a manner that respects Habermas's three speech conditions. It is the job of the facilitator to make sure that all parties have an equal opportunity to raise issues and voice questions as well as providing an environment that ensures all proposals are



Image series 2. In the summer of 2008, a forty-person team representing two countries, eight universities and six disciplines traveled to Mumbai, where they worked closely with local tailors, activists, vendors, students, artists and architects to create a vision for education tailored to the lives of the thousands of children who live on the construction sites of India. The resulting work, which ranged from a **portable earth wall (a)**, a **\$2 water filter (b)** and a **negotiable floor surface** realized using autorickshaw upholstery techniques (c) described not a single school, but a vision that might be used by our non-profit partner, Mumbai Mobile Creches, to inform many schools over a long period of time. [images courtesy International Design Clinic, www.internationaldesignclinic.org]

treated equally. At the same time, the facilitator, a role often filled by the architect or designer, is counted on to overcome some of the harmful, groupthink tendencies brought about by the formation of the group itself: to make sure that minority opinions are given fair hearing and to suggest any ideas that the group might have overlooked in their deliberations. Paradoxically, it is also the facilitator's responsibility to make sure to find "common ground on opinions" and encourage those who differ in position to put aside their differences and "build on the ideas they share." (Cherry, 1999)

Aside from asking the architect to simultaneously upholding conflicting demands (for example, by representing the minority while also building consensus), these roles install the architect as a second point of authority within a supposedly public forum. Although it might seem appropriate for the architect, as the design expert for the project, to assume such a position within a design charrette, current research would indicate that this is a suspect conclusion at best. For example, a recent study comparing the performance the most respected mutual fund experts to the Wilshire 5000 index found that between 1984 and 1999, almost 90% of the experts underperformed the index. Another study found that "the between expert agreement in a host of fields, including stock picking, livestock judging and clinical psychology, is below 50 percent, meaning that experts are as likely to disagree as to agree." (Surowiecki, 2004, 33) Although exceptions do exist, as past success is no guarantee of future results, it seems that the long-term potential of the expert remains somewhat suspect. This has led some to conclude that "... there's no real evidence that one can become an expert in something as broad as 'decision making' or 'policy' or 'strategy.' Auto repair, skiing and perhaps even management: these are skills that yield to application, hard work and native talent. but forecasting an uncertain future and deciding the best course of action in the face of that future are much less likely to do so." (Surowiecki, 2004, 32) Moreover, given the findings in a study by Terrance Odean, which indicate that purported experts like physicians, nurses, lawyers, engineers, entrepreneurs, and investment bankers routinely overestimate their knowledge within their field of study, the installation of the expert-architect within design charrette might actually serve to exacerbate the groupthink already present, only in a manner that falls in line with the thinking of the architect in charge.

These difficulties are compounded by the fact that the same authority figure is also responsible for overseeing the conversation in a manner that meets Habermas's four validity claims: it is the architect who makes sure they are knowledgeable about local conditions, that all parties behave in a manner appropriate to the local culture, that they demonstrate sincerity when attempting to help the group solve local problems and that they communicate effectively to all participants. Unfortunately, this is a role that is impossible to fill. That is, even though the processes of group selection currently used do limit the number of cultural groups present, it is quite difficult to be completely knowledgeable about the problems faced by a single cultural group, let alone two or three. It is equally difficult to make sure that one behaves in a manner simultaneously appropriate to the belief systems of said

cultures. Obviously, the greater the cultural differences of the players, the more profound these inadequacies become. Knowing well these difficulties, Cherry suggests that the architect read several ethnographies on the participating cultures in order to become knowledgeable. (Cherry, 1999, 63-4) Unfortunately, even assuming the architect has the time to read the ethnographies this call would require and is able to avoid poor or out-of-date accounts, it remains quite difficult to image that this method would allow for the facilitator to gain any knowledge on under-represented or newly-emergent subcultures. Surely, reading several ethnographies on Americans would hardly take into account the vast number of subcultures that define the country. As Cherry admits, “a client group does not have to be from a foreign country to have cultural values unlike your own. In many ways, neighborhoods in the same town have different cultures.” (Cherry, 1999, 66) How then would one find accounts of these neighborhoods? These questions become particularly vexing when one practices in a neighborhood completely foreign to previous experience, as is the case with the work of many community-centered or humanitarian designers.

To overcome these limitations, Cherry suggests working with a colleague from that culture, or “informant.” (Cherry, 1999, 66). Unfortunately, this still brings up significant questions: Should one find an informant from each subculture involved or only the important ones? How do we select them? How are these individuals different from the other representatives in the group and what is their place within the decision-making hierarchy? In light of these quandaries, it seems reasonable to ask one final question: Would not the entire process be a lot simpler if the foreign architect just got out of the way?

The answer, quite simply is yes. At least under the auspices of this arrangement.

THE FAILINGS OF CONSENSUS

In the world of participatory design, consensus-building is the ultimate goal: “In terms of maximum participation, consensus decision making is the most inclusive.” (Cherry, 1999, 57) Unfortunately, consensus building is an inherently flawed method of creating dialogue, more often leading to ill-founded conclusions and faulty recommendations than useful insight. The reasons for this extend past the niceties surrounding the deliberation and into the structure of the debate itself. That is, putting aside for a moment the impossibility of so doing, even if a facilitator is able make sure that the group fulfills all seven of Habermas’s conditions, the structure of the open-forum itself will greatly diminish the ability of the group to create the debate and offer the wisdom these conditions are intended to cultivate.

First, the format of the open forum encourages two very harmful group patterns: *information cascade* and *polarization*. Information cascade is a result of the linear process of conversation, in which each insight offered is impacted by that which preceded it. This situation naturally prioritizes the points raised first, instead of those that are judged to be most prudent through argument or thoughtful consideration. Thus, the first person speaking has a profound impact upon the course of the deliberation, and, thus, the conclusion reached. This occurrence is made especially dangerous due to the fact that groups to polarize through debate. According Cass Sunstein, who conducted numerous studies on this phenomenon: “As a general rule, discussions tend to move the group as a whole and the individuals within it toward more extreme positions than the ones they entered the discussion with.” (Surowiecki, 2004, 185) There are three explanations for this. First, during a deliberation, people tend to compare their position to that held by the group. Second, people tend to believe that if lots of people believe a certain thing, they must have a good reason for doing so. This is called “herding” and is demonstrated clearly through an experiment by Milgram, Bickman and Berkowitz. In it, they placed a single individual on a street corner, and asked them to look skyward. As others passed, a few stopped to look skyward as well. After a time, they placed five people on the corner looking skyward, which caused four times as many people to gaze skyward. They then placed fifteen skyward-looking people on the corner, resulting in almost half of all passersby following suit. As they continued this progression, more and more people were convinced to stop and look at the sky, until 80% of the passersby ended up so doing by the end of the experiment. (Milgram, 1969) Third, within a deliberation, extremists, who “tend to more rigid” and are generally “convinced of their own rightness” tend to have greater influence than moderates. Eventually, due in large part to



Image series 3. Projection Mail, a \$3 projection system with a range of over 10'-0", was created to exhibit work without encouraging the voyeuristic tendencies that usually accompany a gallery-based show. The resulting exhibitions, rather than feature a few key images of the final work in a given space, featured hundreds of images that can be focused (or blurred), enlarged (or shrunk) and overlapped (or isolated). Just as importantly, through acts of, [re]positioning (stealing a box and putting it in a new location), [re]projection (projecting the image onto unanticipated surfaces), [re]purposing (through acts of graffiti or the substitution of images) and, [re]presentation (mounting photos of new installations onto Flickr and contributing to the online gallery), the face of the work shifts radically, creating a mobile trans-personal experience that both reflects and rearticulates the relationship between the work, those viewing it, and, invariably, those responsible for re-creating it. [images courtesy International Design Clinic. www.internationaldesignclinic.org/]



the first two tendencies, their conviction is transferred to the group, pulling the debate toward one end. (Surowiecki, 2004, 188)

As people shift their positions in accordance with those held by the group, they tend to leave behind points and ideas that do not find the perceived beliefs of the group. This results in consensus-driven groups squelching debate in favor of the familiar and creating “tepid, lowest-common-denominator solutions which offend no one rather than exciting everyone.” (Surowiecki, 2004, 203) Rather than confront the convicted, the moderates follow suit. Garold Stasser demonstrates this tendency through a simple experiment in which he asked eight people to rank the performance of 32 psychology students. He supplied all participants with two common pieces of information (grades, etc). He also gave two members two extra pieces of info (i.e. performance in classroom) and one member another two pieces. Stasser found that the ratings of the group were based almost entirely upon the two pieces of shared information. All other pieces of data, despite the fact that they were actually quite telling, were discounted entirely. The reason: in unstructured, free-flow conversations, the information that tends to be discussed the most is that which is shared. Any new or innovative messages are generally either modified to fit old messages or discounted altogether. (Stasser, 1985)

At times, this tendency to conform can lead the group to embrace ideas that are blatantly wrong. In Solomon Asch’s famous experiment, he asked nine people to select the longest line on a sheet of paper. The first eight respondents, who were in on the experiment, had been previously instructed to select the wrong line. This caused 70% of the subjects (the final respondent) to select the wrong line at least once and 33% to do so over half the time. Rather than believe their eyes, these respondents believe the group. (Asch, 1956) One can only imagine the sway of the group when dealing with matters of greater dispute than the length of a line.

FINAL ANALYSIS

In order to address the harmful patterns propagated by current participatory practices the architect must shift their practices in a manner that will cultivate a more useful dialogue. This address starts with the recruitment of a much wider body of participants. The community-centered designer can no longer rely upon a single source to determine the correct body of people to invite. Nor can they rely upon mechanisms of advertising for recruitment or a single time and space for discussion, both of which have biases that will not permit the diversity of participation required in a truly community-centered work. Instead, the architect must construct methods of instigating and collecting wisdom at a variety of points and times. Whether in the form of smaller, street-side events or large-scale negotiable installations, the designer must find ways that the wisdom of a wide range of people is collected simultaneously without prioritizing the views of the majority, the powerful or the convicted (image 1). Done correctly, this will minimize groupthink and cascade thinking, both of which occur when decisions are made sequentially. It is worth noting that in Solomon Asch's experiment, when the scientist instructed just one other respondent to select the correct line, the subject did likewise to an overwhelming degree. Apparently, allowing a single voice of difference is enough to encourage most people to stay true to their convictions. Just as homogeneity creates pressures toward conformity, diversity contributes to difference, making it easier for everyone to offer their ideas and truly dialogue.

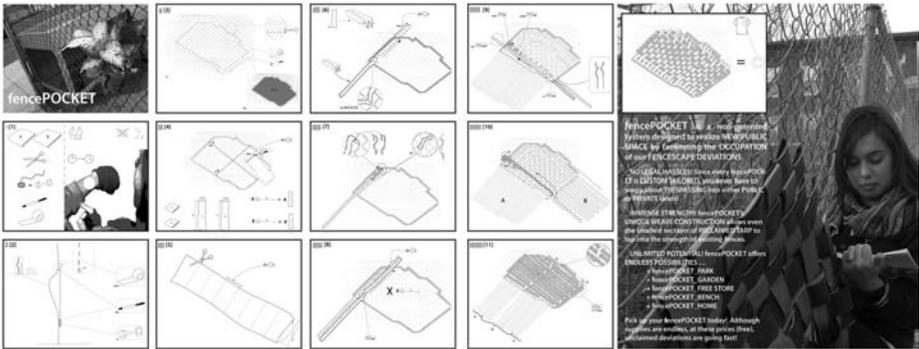
Secondly, the architect must develop practices that allow this diverse body to independently offer their ideas and explore as many alternatives as possible. This notion actually occurs quite often in the world of business. At the birth of a new technology - the automobile, the television, the Internet - there is generally a boom in the number of businesses that grow around the promise therein offered. More businesses than can possibly succeed vie for supremacy, each attempting to offer the best product to the consumer and make the case for their existence. Over time, the customer, through their purchase, judges some ideas to be better than others. Businesses respond to these trends, causing shifts in purchasing, until a much smaller set of products have each found a niche within the market. The market has been developed. Interestingly, bees use a very similar method to find honey. Rather than sit in the hive and discuss the alternatives, gradually choosing a prudent course of action, they send all members of the hive out in every direction. Once the scouts find a nectar source, they return to the hive and perform a waggle dance, the intensity of which is based upon the excellence of the supply. This dance attracts a corresponding number of scouts, which follow the bee to the source. They then return to the hive and perform a similar dance, until the entire hive has effectively divided itself to harvest the most nectar (few bees tending the smaller sources, more tending the larger sources). Although seemingly inefficient, this method is generally quite productive: if a nectar source exists within 2km of the hive, bees will find it over half the time. The bees, like the business market, succeed because they allow everyone to operate independently, in accordance with their own wisdom. This generates lots of losers, which are quickly recognized as such and killed off (image 2). Compare this to the process used by the community-based designer, who attempts to form groups which debate, using only abstractions of the idea (drawings, arguments, etc), and then decide upon a single course of action. It is not surprising that these ideas often fail to produce the desired results. A hive sending out a single forager will likely not realize better.

These new patterns of working will shift the architect's chief responsibility from that of expert, who receives all knowledge and then dispenses it to the group, to that of facilitator, who simply makes specific knowledge globally accessible and then allow the public to determine the best course of action. They will function like a street-based Google, establishing a framework whereby myriad independent sources offers a small bit of knowledge, which is then aggregated to determine the most appropriate result for any given search (image 3). Linux, which was developed by providing an open-source code and allowing anyone with even a small bit of knowledge to contribute their specific knowledge to the global application. To quote author and Linux advocate Eric Raymond: "Given enough eyeballs, all bugs are shallow." (Surowiecki, 2004, 72-3)

It not coincidental that these arguments pull into suspicion other practices of the socially-responsive designer, which generally position the designer as a single point of wisdom, tasked with understanding "the available resources, tools, desires and immediate needs of their potential users" and to "design



image series 4. fencePOCKET Every time a chainlink fence deviates from the edge of a site, it creates a thickened line between public and private. fencePOCKET uses simple, repetitive techniques and reclaimed tarp to instigate the occupation of this site. fencePOCKET can be tailored to any size deviation and welcome practically any program, including fencePOCKET|FARM, fencePOCKET|GARDEN, fencePOCKET|freeSTORE, and fencePOCKET|BENCH. [images courtesy International Design Clinic, www.internationaldesignclinic.org]



simple, functional, and potentially open-source objects and systems” for the good of many. (Bloemink, 6)⁴. Yet, the hero architect may not have a place in the world of participatory design. A study on the role of intelligence within group dynamics by political scientist Scott Page would seem to give some credence to this belief. In this experiment, Page created placed computer-simulated problem solving agents of varying intelligence into teams. He then asked these teams to perform problems of ranging complexity. Page found that teams consisting of some intelligent agents solved better than teams with all intelligent agents. (Surowiecki, 2004, 30) It seems that successful participatory design practices, like successful development communication is not about the brilliance of the few, but of accumulating the wisdom of the many (image 4).

For the architect, who cannot possibly be fully knowledgeable in all areas touched by participatory design practice, this is likely good news.

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ENDNOTES

¹To an extent this is an altogether tactic. After all, many practitioners have argued that all works of architecture are of interest to the general public and, thus, should employ participatory practices. To quote author Edith Cherry: "Buildings, almost without exception, are for people ... [therefore] we use the term clients to mean all of the people associated with a facility. Clients are owners, agencies, users of facilities, and the general public." Cherry goes on to say that "architecture is the most public art...there is an implied responsibility to have projects serve the more positive values of a community." (Cherry, 1999, 51-3)

²Although not all designers share the conviction that architecture is an inherently public art or that the public should be involved at all in the process of designing and constructing architecture, several widely-accepted architectural practices would seem to indicate that the public remains a concern. However, it seems equally obvious that socially-responsive practices are not isolated to those who practice community-based design, as evidenced by the number of field as a whole has adopted several techniques of data gathering that speak directly to these concerns.

³In most cases, they also play a key role in determining even the methods used to execute either mechanism. In regards to post-occupancy evaluation, Prieser postulates that (the) commitment to clients and how they prefer to gather information is more successful than any particular technique."

Intelligent Skins: Daylight harvesting through dynamic light-deflection in office spaces

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ABSTRACT:

The building envelope is the critical interface between the occupants and the outdoors. This surface has the ability to be interactive; it can incorporate intelligent features, activated by sensors that respond in real time to a change in environmental conditions. A kinetic façade could use simple movements of louvers, complex transformable panels, or even variable material characteristics such as transparency or reflectivity that react to stimuli.

Daylight harvesting is one area where a kinetic façade can be used to help achieve lower energy consumption in office buildings while also mitigating some of the negative impacts of introducing natural lighting into a building including uneven distribution of day lighting, illumination levels above or below the recommended range, and excessive heat gain affecting thermal comfort. This paper provides a brief insight on the primary author's current thesis work regarding light-deflection techniques. It explains the objectives of the research work and documents simulation runs for the first phase of performance analysis including initial modelling and analysis of a parametric panel system. Although these initial studies focus on relatively simple geometries, it is intended that the method of analysis will be applied to increasingly complex forms to demonstrate that a kinetic façade system can be both aesthetically compatible to complex geometries and contribute to better energy performance of a building.

The study focuses on investigating the effectiveness of light deflection in dynamic secondary skin layer in terms of daylighting performance, quality and quantity, in south-facing indoor spaces using a set of performance criteria. A simple example was developed and simulations run to see if the performance criteria could be achieved using Rhino as a modelling tool, Grasshopper as a parametric interface, DIVA for daylight evaluation, and Galapagos for problem solving.

The authors hypothesize that the integration of light deflection techniques in an intelligent dynamic panel system allows for the enhancement of daylight harvesting, quantity and quality, inside south-facing spaces.

KEYWORDS: kinetic façade, daylight harvesting, interactive architecture, intelligent skin, building envelope

INTRODUCTION

In the United States, lighting accounts for almost 30%-25% of total electrical energy use and in the commercial sector up to 37% (Phillips 2004, 38). Electric lighting also has an indirect effect on cooling loads in spaces, and as a rule of thumb, each unit of electric light requires an additional one-half unit of electricity for space conditioning. Lighting efficiency, in terms of less electrical consumption in buildings, can be improved by simply using less artificial light and taking advantage of available natural light. This is an obvious statement, but ironically, although the use of glass in office buildings has become an iconic element in the architecture profession, interior lighting has not always improved.

Typically, the daylight depth in a room with an untreated opening is about one and a half times the distance from the window head to the floor (O'Connor 1997). A typical window head is at 2.20m, which results in a 3.30m room depth of daylight area, given the previous ratio (figure 1). One method that allows for better daylighting efficiency is redirecting light either into or out of the space, commonly referred to as light-deflection. Often the primary use of these devices was to block daylight from entering the interior space. Light deflectors block light by re-directing it away from the occupants' line of sight, protecting inhabitants from glare and heat gain from direct sunlight. Light shelves and other techniques can be used for both light deflection and daylight harvesting. Using the example in figure 1, light deflection techniques, such as light shelves, can increase the penetration ratio up to twice as much, giving a larger room depth of 4.40m with daylight.

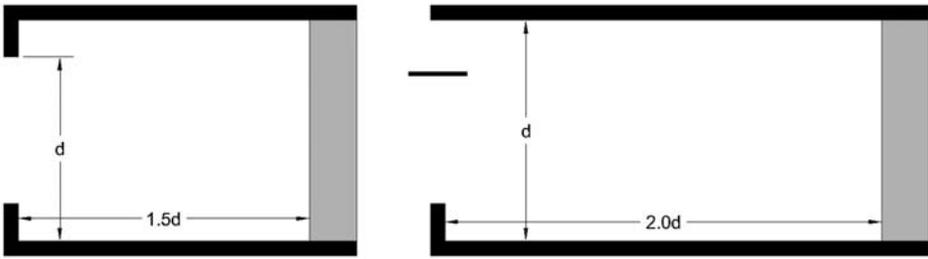


Figure 1: The figure on the left shows the depth of daylight in case of untreated window opening while the right figure shows the extended depth up to two times using light shelves.(O'Connor 1997)

The introduction of the light redirection technology can have a great impact on the performance of facades in optimizing daylighting. Light deflection devices have been proven to efficiently increase the performance of daylighting in interior spaces, by redirecting light deep into the space minimizing the undesirable effect of direct sunlight and the use of electric lighting. While these techniques have the same objective of increasing the amount of daylight in interior spaces, they are not suitable for every building. Daylight problems are mostly treated individually where system customization is sometimes required. The customization does not have to be major alteration of an existing technology, but could be a minor addition that makes the system fit within the design problem and context. These systems are usually referred to as passive daylight systems; they allow for better lighting inside the spaces while being static. While passive systems enhance the performance, they lack the flexibility of adapting to changing outdoor conditions. For example, light shelves are stationary, but the incident angle of sunlight is changing with the sun's path making the shelf effective on certain times and days and ineffective for the rest of the year or under different sky conditions. Given the limitation of passive systems, designers started adopting active control systems that led to introducing kinetic techniques in the profession.

The purpose of the daylight deflection, besides protection against glare, is to control the intensity, direction, and distribution of light. This can be achieved by controlling the amount of light penetrating through the building envelope and reflecting unnecessary light back to the outdoor environment. In his book, Koster mentions that the efficiency of daylight deflection system is directly related to these factors: the type of the deflector, physical properties of the deflector, location of the system in the building, and mounting position relative to the space (Koster 2004). He also discusses the main purpose of using light deflection techniques-- they should provide protection against solar heat and glare and control the supply of light, thereby improved indoor illumination. The advantage of light-deflection techniques over solar shading is the ability of working as a control layer and strengthening low daylighting levels, specifically at the back of a space.

“In practice, the shading systems are closed during periods of the largest solar gains (direct solar radiation), darkening the interior and resulting in a need for artificial lighting. This is a waste of energy that could be avoided, especially since the total electrical energy for lighting is transformed into heat that must be removed in summer by an energy-intensive interior cooling system.”(Koster 2004, 80)

This statement addresses the need of exploiting light deflection and controlling light penetrating into the space. Instead of possessing one function, efficiency requires shading devices to minimize solar heat gain and control light by blocking it or bouncing it off appropriately into the spaces, without wasting free solar energy and consuming more electric light.

Architecture is experiencing a demand for responsive-based designs, where the occupants' comfort level is being achieved through the use of smart systems. Integrating light deflection techniques into an intelligent envelope system of the building is the main goal of this study. Intelligent features may add more control layers to a kinetic system by gathering data, interpreting its impact, and reacting appropriately to unforeseen circumstances, whether environmental or occupants' behaviour.

OBJECTIVE

An optimum visual environment in office spaces through the use of daylight is crucial for employees' comfort, productivity, and morale (Dasgupta 2003). Visual comfort and potential energy efficiency is addressed through five main parameters: light level (illuminance), luminous distribution, glare, light penetration depth, and direct sunlight. An intelligent dynamic light-deflection system should provide daylight levels over a range of possible sky conditions (including clear, variable, and overcast), be within a recommended range, have an even distribution of daylight inside the space, and allow deep penetration of daylight beyond the typical one and half times or two times ratio explained earlier (O'Connor 1997). In the context of this study, the quality of light is defined as the acceptable luminous distribution of daylight on the working plane and the penetration of light for more than two times the window header height. The quantity of light is referred to as the illumination levels on the same working plane.

The objective of this tool is integrating daylighting performance into the early design stage of the project. While the main objective is providing a tool that simulates daylighting at different times and compiles an actuation scenario for a secondary skin, it can be used to find an optimal solution for a static louvers skin that enhances daylighting for as many days of the years. The tool is intended to enhance the process of designing kinetic facades that respond to daylighting and enhances the indoor luminous environment.

METHODOLOGY

The study focuses on investigating the effectiveness of light deflection in a dynamic secondary skin layer in terms of daylighting performance, quality and quantity, in south-facing indoor spaces using the performance standards discussed earlier. The proposed approach involves exploring independently actuating louvers on a secondary skin layer in combined schemes. There are infinite possibilities of combined skin configuration for intelligent-kinetic louvers system; each louver may have its own tilt angle. Therefore, the best approach for this study is using parametric software that automatically generates as much possibilities as the designer desires.

A simple example was developed in search for indoor luminous conditions that fit performance criteria. This was done using Rhino as a modelling tool, Grasshopper as a parametric interface, DIVA for daylight evaluation, and Galapagos for problem solving.

Rhino (<http://www.rhino3d.com/>) is a 3d NURB-based modeling program. Until relatively recently, it has not been easily used in conjunction with simulation software. Now DIVA-for-Rhino supports a series of performance evaluations including links to Radiance, Daysim, and Evalglare (Rheinhardt et. al., 2010).

Grasshopper (<http://www.grasshopper3d.com/>) is a free, graphical algorithm editor tightly integrated with Rhino's 3d modeling tools. It is possible to integrate pseudo-environmental effects such as sun and wind to dynamically change form. Sun systems have also been developed for it to achieve accurate sun shadow simulations, and two-way connections to and from Ecotect have been demonstrated.

DIVA is a Rhino plugin for daylighting simulation. The plugin runs a commonly used simulation engine, RADIANCE, and it can be directly run from the Grasshopper interface through using a pre-built component provided through Harvard GSD (SD)2 website. This component allows data exchange between DIVA and Rhino, and uses Rhino as an interface for showing the results and the visualization. DIVA calculates illumination levels, daylight factors, glare, and provides visualizations in the form of calculation grid diagrams and renderings.

Adding to the efficacy of the experiment, a genetic algorithm has been incorporated into the definition to enable a search of the best skin configuration at specific dates and times, or under different sky conditions. A genetic algorithm works by searching for an optimal solution under certain parameters and conditions. For example, a single desired solution might be acceptable indoor illumination levels; parameters might include tilt, depth, and number of louvers; and given inputs could be latitude, sky condition, and time constraints. Changes in any of these parameters trigger the system to run and find an optimal configuration for the skin to maintain the desired luminous environment.

Galapagos is a genetic algorithm feature that is used for problem solving cases within Grasshopper. It creates an evolutionary generic loop that populates generations of possible solutions with random individuals based on the predefined criteria. The system couples similar possible solutions together and then finds a best fit solution which may end up being a locally optimal solution in some cases. *Galapagos* is intended to be used in this study to find the best possible tilt angles of the louvers' configuration for certain times of the day. However, *Galapagos* will be running off a pre-defined set of parameters, leaving only the calculation for this tool. For all simulations, data will be documented for June 21st (summer solstice), December 21st (winter solstice), and March 21st (equinox), each at 9:00 am, 12:00 pm, and 4:00 pm.

Integrating *Galapagos* and *DIVA* into one algorithm extends the capabilities of basic daylighting simulation by not just calculating a single answer to a set of givens, but trying to discover what set of parameters gives the "best" solution to the problem. Although the algorithm's objective is to search for an optimal solution, it does not necessarily find the best possible solution. It may present a solution that is found to be relatively better than others. *Galapagos* operation is single-numerical value dependent, which means the performance criteria should be translated to a single numerical value. For example, if the performance criteria require the sum of all nodes to be 1800 Lux as an average illuminance value, *Galapagos* will run to find solutions that give either a value close to 1800 or a value that is far away from this number. In our case study, a solution that maximizes the number to be close enough to the fitness numerical value is desired.

Although it is possible to create and test extremely complex geometry with these software tools, a very simple test case was established to verify that that method would actually work. As will be discussed later, problems did develop even with the base case. The simple base case is a series of louvers arranged horizontally above each other, divided into two sets each actuated independently. Figure 2 shows the combined configuration of the louvers where three louvers are in shading position, and the other two louvers are in a harvesting position to deflect light further into the interior space. This configuration is intended to spread light more evenly inside instead of concentrating the light in certain zones.

The interior space is divided into four different zones each with nine light sensors/calculation points. The sensors measure the illumination levels on the workplane and illustrates it graphically in the form of on-screen readings in Rhino viewports. *DIVA* also allows the user to extract the readings in the form of numerical values that can be used again in the simulation loop.

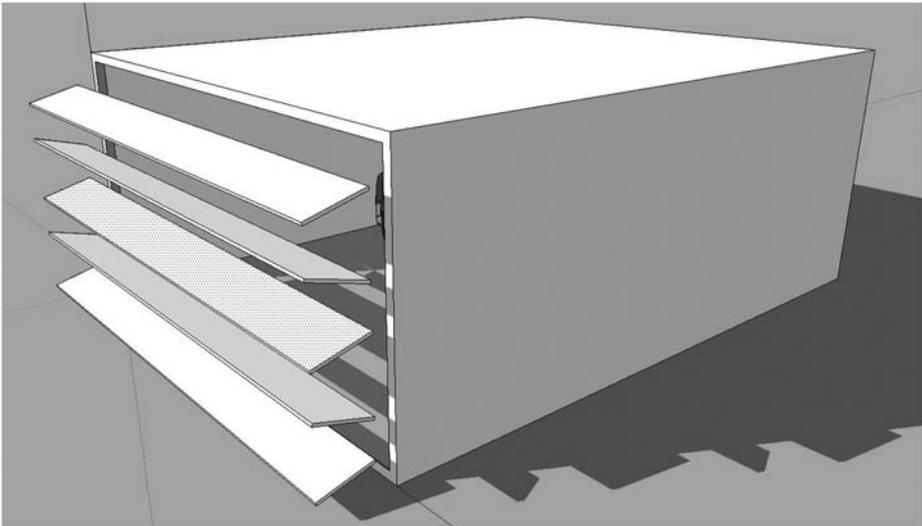


Figure 2: The figure shows the independent tilt angles of the exterior louvers.

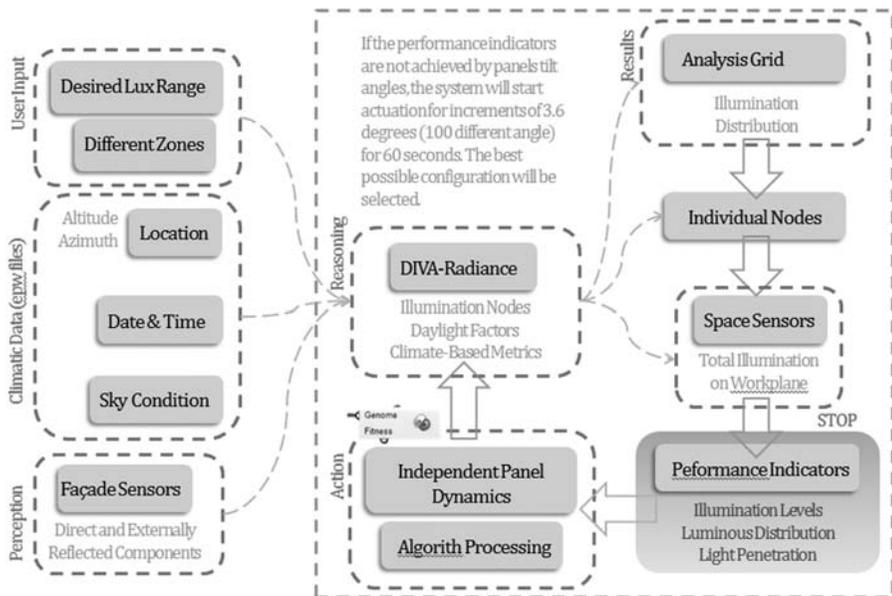


Figure 3: The figure shows the specification of the proposed system together with the data workflow.

The proposed system is intended to have three main inputs: user, climate, and sensors (figure 3). All inputs are processed through DIVA/Radiance, and then results are shown in the form of analysis grids. Using Grasshopper, readings are extracted separately and matched against the pre-defined acceptable conditions. If these readings match the acceptable ranges, the system will stop the calculation process. If they do not match the performance criteria, the system will repeat the calculation process until the best possible tilt angle is found. The panels have been set to rotate in increments of 3.6 degrees, one hundred possible angles.

The DIVA definition in Grasshopper calculates and provides the sensors' illumination readings. If they go outside of the recommended range, it will order the panels to move in certain angle increments until a minimum of three of the zones fall within the recommended range. An angle increment is to be set for actuation as well as a maximum time for searching for the best tilt angle. For example, if the allowed maximum calculation time is 5 minutes, the five large panels will actuate to find the best angles that achieve the best illumination level inside the space. If this angle is not found in 5 minutes, the system will choose the best possible calculated configuration to bring illumination level closest to the recommendation.

SIMULATION CRITERIA

There are infinite possibilities of combined skin configuration for intelligent-kinetic louvers system since the proposed system depends on independent angle control, where each louver may have its own tilt angle. Therefore, the best approach for this study is using parametric software that automatically generates as much possibilities as the designer desires. In order to speed the process (and due to some software limitations that did not allow for the full range of tilt to be studied), it was decided not to adjust each louver at a specific tilt angle but to use some results from another study. In 2005, a MIT student explored the independent blind angle control for venetian blinds and its impact on ceiling illuminance. Using physical models, she was able to establish conclusions for light-reflection on the upper surface of venetian blinds. In her research, she presented three equations for three variables: incident angle, reflected angle, and blind tilt-angle. These equations are useful in determining the reflected angle, which consequently gives hints about where the light is going into the space. The tilt angles that McGuire used for testing were 26° & -17°, 52° & 41°, and 30° & 60° (McGuire 2005).

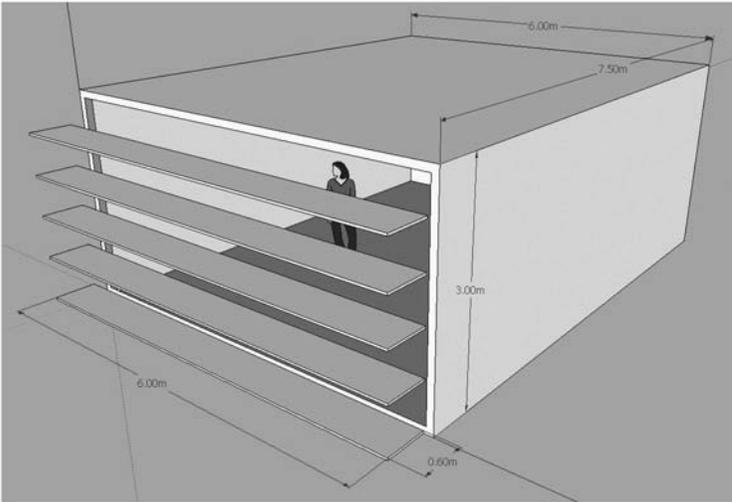


Figure 4: The figure shows the dimensions of the office space used in the simulation.

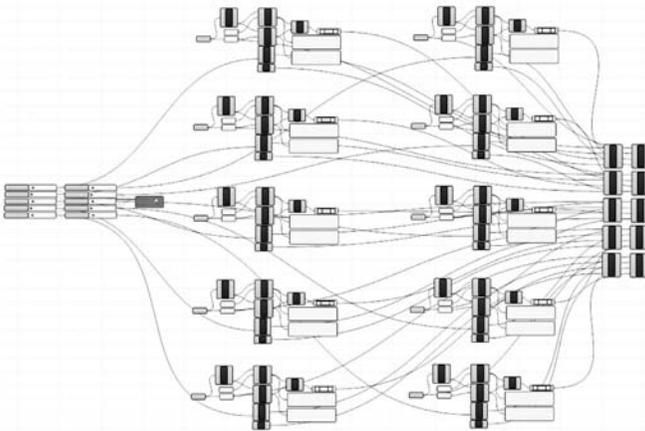


Figure 5: The figure shows part of the Grasshopper definition that illustrates the ten louvers with the angle sliders on the left hand side.

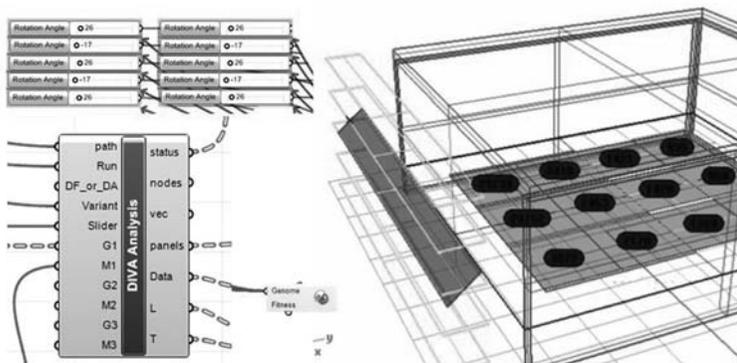


Figure 6: The figure shows the interior calculation grid/sensors with one of the louvers rotating to adjust the quality and quantity of the daylight inside the space.

The modelled space in Rhino has dimensions of 6m width, 7.5m depth, and fully-glazed height of 3.0m (figure 4). This office space has been divided into four main zones: two close to the window opening and two at the back of the space. The interior surfaces have been assigned reflectance of 80% for ceiling, 50% for walls, and 20% for floor. The secondary skin panels have reflectance of 90%. The opening has been assigned generic doubled glazed material with 72% visual transmittance. Because of its sunny weather and daylight availability, Los Angeles has been chosen to be the location of the test and this south-facing office space.

Initially, the louvers system has been divided into five main louver levels where each level has two louvers (figure 5 and figure 6). It is intended to control each of the ten louvers independently with different tilt angles. However, at this point of the study and for quick simulation runs, each two louvers on the same level are similarly treated with the same rotation angle.

The analysis method is dependent on three main qualities of daylighting: illuminance, luminous distribution, and light penetration.

ILLUMINANCE

Different organizations recommend different light levels of illuminance for office spaces. The recommended illumination levels according to the Illuminating Engineering Society of North America (IESNA) for a typical office space is 200-500 lux (IES North America 2000). The NRC Institute for Research in Construction recommends levels of 400 – 500 lux for typical office work (National Research Council Canada). In terms of daylight factor, the recommended percentage is 2% – 5% (IES North America 2000). This study targets a level of 300-500 lux taking into account that values not less than 200 lux and higher than the recommended range may be acceptable in some areas of the space, under certain conditions.

LUMINOUS DISTRIBUTION

For better visual environment, the IESNA recommends that, within the occupant's field of view, the ratio between the maximum and minimum illuminance should not exceed 1:10 (IES North America 2000). However, the NRC Institute for Research in Construction recommendation exceeds that of IES and goes up to 1:20 (National Research Council Canada), providing an acceptable argument for this high contrast, like highlighting certain object on the working plane. Sometimes due to high contrast, the occupant perceives parts of the space as dark which in reality actually has sufficient light levels. Maintaining this ratio prevents the false perception of light level inside spaces. Within the framework of this study, ratios up to 1:20 will be acceptable.

LIGHT PENETRATION

Untreated window openings allow light penetration one and a half times the distance from the floor to window head. Incorporating a light shelf extends the ratio up to twice the distance (figure 1). Within the context of this study, the target is for two and a half times this vertical distance with the use of light deflection devices.

SIMULATION RESULTS

The simulation has been run once with no secondary skin – just the glazing – and three times with different tilt angles (figures 7, 8 and 9 described in the four coming sections). In the first two runs, the panels were in shading positions with two different angles in each case, while in the third run, the panels were in combined position with another two different angles. All other factors, otherwise previously noted, have been fixed for fair comparison. For all simulation runs, the time and date have been set to August 21, 12:00pm. Initially and until the Grasshopper definition is fully developed, the tilt angles' selection has been manually simulated, taking into consideration that in the future the definition will select the angle based on pre-defined parameters. Although disappointing that that tilt angles had to be manually adjusted, when the software bug is fixed, refinements to the solution set will be made.

In the following three sections, a diagram is repeated many times as an explanation to the simulation runs (figures 7, 8 and 9). The green text on the left side of the figures is a diagram legend for the calculation grid plan view. It is divided into four legends based on the number of grids inside the space. First text legend refers to the lower left grid. Second text legend refers to lower right grid. Third text legend refers to upper right grid. Fourth text legend refers to upper left grid.

SHADING CONFIGURATION (30 AND 60 DEGREES)

The exterior panels have been tilted to 30 and 60 degrees in a shading configuration (figure 7). With this configuration, the simulation showed a 50:50 result; the front two zones are overlit while the back zones are within the acceptable daylight factor range (figure 7). The high-angle sun emits light that is reflected by the panels and intensively deflected into the front portion of the space. Light is bounced off the 30 degrees panels, reflected on the back surface of the 60 degrees ones, and deflected into the front half of the space. Given the performance indicators mentioned in section 1.1, these results are not acceptable; thus the tilt angles are not successful in achieving good daylighting quality and quantity inside the space.

SHADING CONFIGURATION (52 AND 41 DEGREES)

The simulation has been repeated with another set of tilt angles – 52 and 41 degrees – in a shading configuration. The results were more promising than the first run (figure 4). The overlit area is less, which means less light deflection is concentrated in the front zone. However, a partially daylit area showed in the back portion of the space. The upper right zone is relatively the best zone in this run where no overlit areas are present and only 22% of the zone is partially daylit. Though this run shows better results compared to the previous case, it is still far away from the research objective which targets even distribution of acceptable lighting levels inside the space.

COMBINED CONFIGURATION (26 AND -17 DEGREES)

This run is different from the previous ones. The panels are set to combined configuration; panels 1, 3 and 5 are tilted to 26 degrees in a shading configuration that blocks more light from penetrating into the space, and panels 2 and 4 are tilted to -17 degrees in a harvesting position that deflects more daylight into the space. This skin configuration makes use of some of the light and blocks the unnecessary portion. The sunlight hitting the harvesting panels is deeply deflected into the space to maintain illumination levels within the desired range. Light is partially blocked by the 26 degrees panels, falls on the -17 degrees louvers, and deeply deflected into the back of the space. So, intense light is blocked from over-illuminating the front of the space and the back of the space get more light which makes it fall within the desirable range. Unlike the previous runs, this configuration overcame the partially daylit areas at the back of the space and minimized the overlit area at the front of the space by putting 33% of each of the front zones in the acceptable daylight factor range.

SIMULATIONS' CONCLUSION

The results for the three simulation runs are part of the first simulation phase of the primary author's current thesis work. By comparing the previous three tilt angle configurations, the combined configuration of -17 and 26 degrees is, so far, the most successful and has more potential for better performance. When comparing the three cases against each other, the 30-60 degrees configuration has a 50:50 performance; half of the space is within the acceptable range and the other half is overlit. As the tilt angles are changed to 52 and 41 degrees there is better distribution of daylight inside the space but the space is still over lit at the front of the space and partially lit at the back of the space. The combined configuration of 17 and 26 tilt angles optimizes daylight inside the space; it increases the percentage of daylight zones and minimizes the overlit areas. Figure 10 shows the illumination levels in Lux for each of the three configurations in addition to the base case with static horizontal louvers. The static horizontal louvers case and the 60-30 degrees case showed almost equal results in

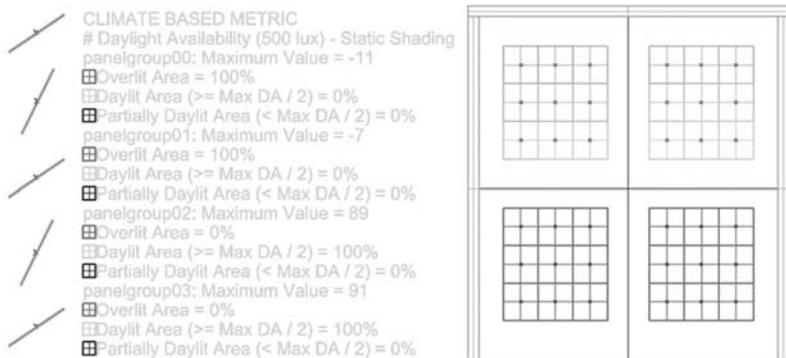


Figure 7: The figure shows the daylight factor results of panel configuration in shading position with angles of 30 and 60 degrees. The image on the right shows a top view of the interior space enclosing four independent calculation grids located on the work plane.

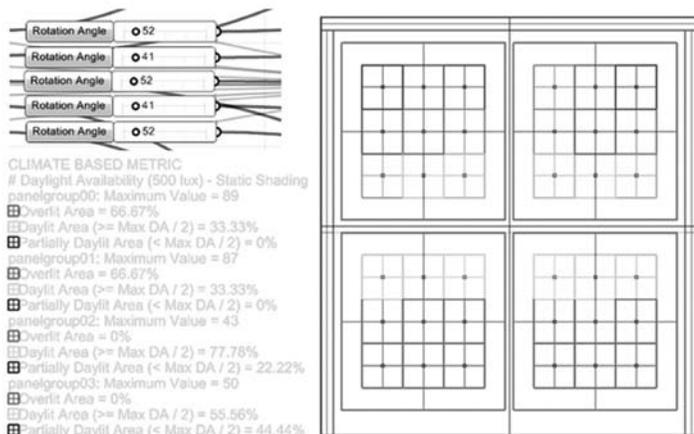


Figure 8: The figure shows the daylight factor results of panel configuration in shading position with angles of 52 and 41 degrees.

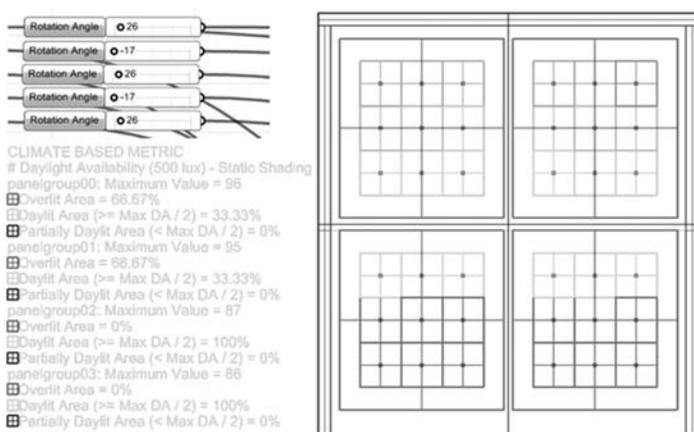


Figure 9: The figure shows the daylight factor results of panel configuration in shading position with angles of 26 and -17 degrees.

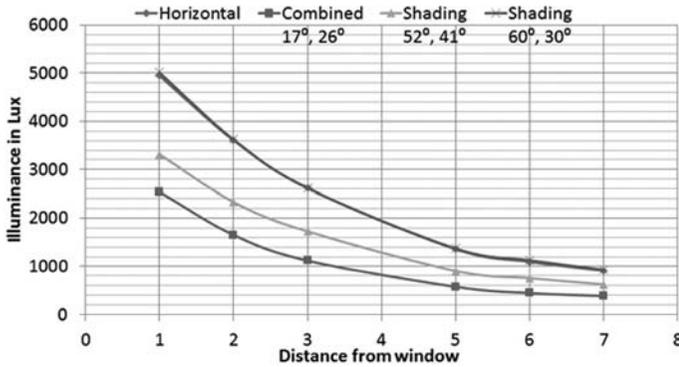


Figure 10: The figure shows illumination levels chart for four panel configurations including the base case with static horizontal louvers.

illumination levels. It is intended to proceed further by simulating the results of louvers that move every 15 minutes with a fixed louver system.

OPPORTUNITIES AND LIMITATIONS

At this early stage of the study, the algorithm is not fully developed; thus using this methodology as a design tool presents some opportunities and limitations. This tool presents a single solution for the design problem through the use of horizontal rotating louvers, which is definitely not the best solution for low solar altitudes. However, it would not be difficult to change the geometry and parameters in Grasshopper for other design ideas. The extensibility of this algorithm makes it open to the integration of more variables into the process as the tool develops. This opportunity allows designer to customize the input parameters according to the real project's experiences. Thus, designers can test numerous attributes against each other and decide on the changes that achieve the most desirable luminous environment, in terms of cost, aesthetics, and/or materials.

As for daylighting, there are many other different attributes that were not covered in this example. Only three attributes were studied: the illumination levels, luminous distribution (contrast ratio), and the penetration depth of daylighting into the back of the space. More aspects like glare, surface brightness, surrounding urban context – resulting in externally reflected components – could be explored in future studies.

Future work includes finishing the Grasshopper definition and defining the constraints for the Galapagos problem solving simulation. The most important and challenging part of this phase is extracting individual readings for each sensor/calculation point and linking it to the parameters for the Galapagos run where it will only be used for the running a large number of solutions and finding the best based on the constraints. Then the skin will be divided into four zones and each enable to act independently to adjust the maximum possible area inside the space in terms of daylighting – quality and quantity. It is intended to test the applicability of the system on complex geometry and assess its performance on such forms against regular ones. It is also planned to provide animation for the panels' actuation that shows instant illumination changes on the work plane. This visualization would be useful in providing the designer with a quick scenario of the dynamic process and its impact of the quality of day lighting.

CONCLUSION

Daylighting is a variable natural force that changes due to the sun's apparent movement in the sky. A fixed louver system would only be efficient during certain times of the day, while a dynamic system would be able to respond to variable environmental conditions. Independent rotation of the louvers in a secondary skin system is one kind of performance-based dynamic system. The use of independent tilt angles for secondary skin panels have strong potential for achieving better daylighting performance. The combined configuration of shading and harvesting positions showed strong potential for successfully achieving the objective of the study. It is capable of directing more

useful light into the back of a space and at the same time blocking strong light levels at the front of the room, thus resulting in optimizing the quality and quantity of daylight in interior spaces.

By providing reliable fast-calculating algorithm and comprehensive visualization in the form of animation, the proposed workflow presented in this paper extremely contributes to the ability of the designer to account for daylighting performance during the design phase. It enables the designer to account for changing conditions of natural forces, specifically the sun. The use of DIVA component in Grasshopper brings the analysis tool to native modelling software, Rhino. This minimizes the use of many interfaces and experiencing disconnection in data exchange between multiple software programs, thus increasing the analysis process speed and minimizing possible errors.

An original intent of the study was to demonstrate that a kinetic façade could be used in harmony with complex parametric design to provide better performance without compromising the intent of the designer. Although this objective was set aside for future work, the authors still maintain that it is critical that more research is initiated at the intersection of innovative architectural design and building science. The resultant performance based design solution must also be compatible with the designer's aesthetic. High performance buildings should also be beautiful buildings.

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User-Participation and the Design Charrette: A Systematic Approach to Furthering Design Process

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ABSTRACT:

Research in architecture is a many-splendored thing. Technical questions on energy efficiency or materiality, social inquiry on user habits or satisfaction, and philosophical queries about the sense of space and place, all fall within the accepted realm of architecture and its creation. Much less considered is how the design process itself may purposefully be used as a research tool to elicit information that will adjust its outcome. This is perhaps because design is often considered “intuitive” rather than systematic, but it is nevertheless surprising when one considers the central role that design takes in architectural education, and more surprising still when one discovers that related disciplines, such as geography, have begun to examine pre-design steps for their research applicability. This paper examines how design – in this case the design charrette – may explicitly be used as a research methodology to change the very planning dialog that it is drawing upon for its process decisions, or put another way, how the designer uses focused discussions with user groups to obtain information vital to the planning process, while at the same time using the ensuing product to stimulate discussion beyond what would be possible without the design. Drawing on a case study taken from the teaching environment, this paper takes the position that design, both as an iterative process and as a participatory field-research process in the form of charrettes, may successfully be employed as a methodology to establish a dialog between researchers (in this case student-practitioners) and user groups. The latter provide initial design information to the researcher while at the same time using evolving products of the research to help define further parameters for exploration. This methodological approach has helped to focus the student-architects on genuine aspects of design problems, as opposed to self-fabricated ones.

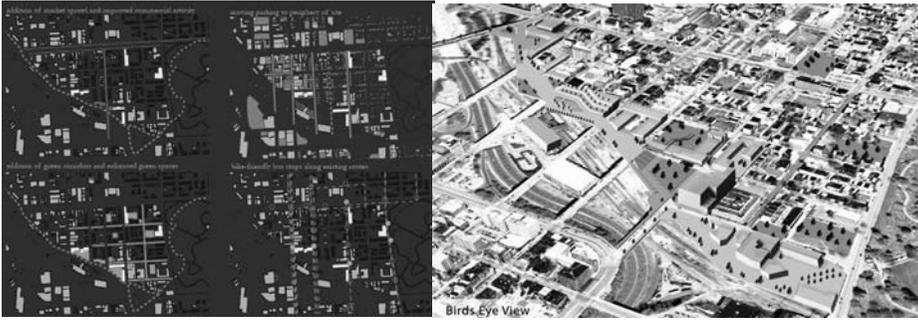
CONFERENCE THEME: On Approaches

KEYWORDS: design, charrette, community engagement, participatory process

RESEARCH AND THE URBAN DESIGN PROCESS: A QUESTION OF METHODOLOGY

Charrette (shar-ette) n. An intensely focused activity intended to build consensus among participants, develop specific design goals and solutions for a project, and motivate participants and stakeholders to be committed to reaching those goals. Participants represent all those who can influence the project design decisions (Lindsey et al. 2003).

The term “charrette” is often defined as a very individual and personal experience of problem-solving and meeting deadlines, yet increasingly this idea of intense focus on a set of questions has come to involve a more wide-reaching agenda, namely one of collaborative efforts to find solutions to a stated problem.¹ Closely associated with what has been termed the “Integrative Design Process,” (*Integrative* replacing “Integrated,” stressing the process-oriented approach) the charrette as a tool to elicit information that will adjust design outcomes has become an iterative process based on multiple inputs and feedback loops in design decision-making (Boecker, et al., 2009). The design charrette as a process tool conceptually parallels and augments innovative research methods used in other disciplines, and it is our argument that a more encompassing approach to using such tools can expand and strengthen the architecture and urban design process. In this article, we will discuss the limitations of current research methods as they relate to the this process, and we will present a case study taken from the classroom, in which we use the design charrette as a tool to overcome some of those limitations.



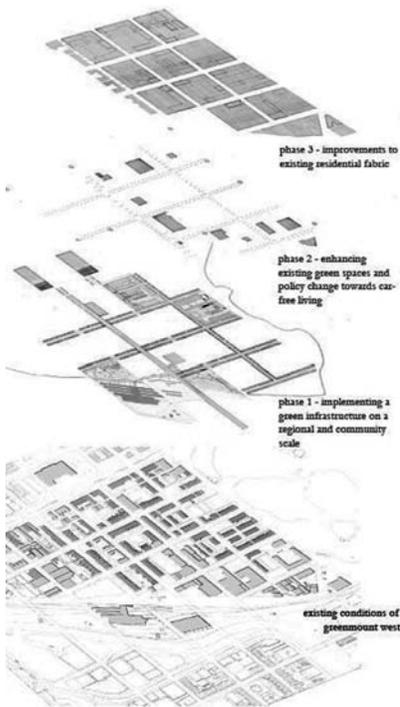
Visualizations: Students' initial design propositions based on qualitative research.

There is much overlap between the pre-design process, where architects gather information about and analyze the parameters of their project, and research methods used in other fields. Despite this, architects and urban planners rarely theorize their approach in the manner that is typical for other disciplines. Grounded theory for example, its roots lying in sociology, uses an iterative process of observation, taking notes and photographs, and interviewing participants, after which data is compared and analyzed to determine further themes for exploration.² In architecture, an applied version of grounded theory is often used in the pre-design process of urban projects, especially when user-groups actively provide input for the design process. Here, observations and interviews provide specific data to aid in design decisions, with correct interpretation of the data crucial to the design implementation's success. Much groundbreaking theory building in urban design has involved versions of grounded theory, such as Kevin Lynch's seminal study of how individuals create mental maps of an urban landscape (Lynch 1960).³

Lynch's mental mapping extends into the area of visualization, a technique frequently used in geovisualization in cartography, although the term is also used in scientific visualization, where such things as volumes and surfaces are rendered in three dimensions, and information visualization, which tries to present abstract information in intuitive ways such as graphs and maps.⁴ The interactive interface possible with computer simulations has been used extensively to visualize complex information in engineering fields and cartography, but has yet to be fully explored in architecture and urban design, where computer use is often limited to examining formal aspects of buildings or simulating energy use. Studies of site conditions are often limited to analytical overlays to existing mapping information. In both cases information is formalized and thus finalized, presenting a specific viewpoint rather than garnering new input to critically further design development.

Maps and visual communication tools, while relied upon as truthful navigation tools, are thus rarely as straightforward as they seem. They communicate information as valued or deemed relevant by the sponsor and/or cartographer. While maps – especially when used in the context of GIS (Geographic Information Systems) – communicate quantitative data, quantity alone does not indicate relative value, especially when there are different opinions as to what constitutes importance. Architect and urban planner Rafael Fischler has investigated the power embedded in such communicative information, specifically in what planners value and *how* (emphasis Fischler's) planners communicate information to exercise power. He reveals two sides to the "power" coin – while communication tools can reveal biases in the interest of influencing behavior, such power may also be necessary for effective management. Analyzing the form of representations used in planning practice can thus reveal both the structural biases of planners' interventions and the strategic value of their statements in particular circumstances (Fischler 1995). Urban planners have begun to recognize this, with many now turning to interpretive methods in order to understand what collective decision-making or the application of knowledge to action specifically means.

Geographer J.B. Harley also explores "the discourse of maps in the context of political power" (Harley 1988, 278). Using three theoretical vantage points – maps as a language that translates into "historical practice," maps as iconography used to identify both literal meaning or the geography and symbolic dimension associated with a message, and maps as a social product – he interprets maps as



Student site documentation and initial propositions for design improvements. Project by Michael Costa, Miriam Lott, Wei Yee Lu, Sohayla Movahedi-Lankarani.

a form of discourse largely controlled by dominant groups, and expresses concern that maps are an impersonal type of knowledge that tends to “desocialise” the territory they represent and foster the notion of “socially empty space” (Harley 1988, 300ff).

Geographers LaDona Knigge and Meghan Cope have identified some of the inherent power issues associated with visualization techniques. Expanding on qualitative methods as both a research and communication tool, they have attempted to circumvent some of the problems associated with visualization in developing what they term “grounded visualization,” a method they call “iterative and recursive...[allowing] simultaneous consideration of particular instances and general patterns, and [encouraging] multiple views and perspectives for building knowledge” (Knigge and Cope 2006, 2022). In part a critique of the indiscriminating use of GIS as solidifying existing power structures through ignoring alternative perceptions of data, their work is a formal and integrative combination of quantitative and qualitative methods as a tool for understanding difference, context, and power, which in the urban design process would translate into incorporating various participant perceptions along with an analysis of physical measurements into the design process.⁵ As they put it, “Displaying quantitative spatial data in a variety of ways may reveal patterns, and statistical analysis may reveal correlations, but it is often the case that explanation (and thus theory building) is grounded in the experiences of real people living through specific conditions and they are in many ways the ‘experts’, even if their explanations seem to be at odds with other sources of data,” (Knigge and Cope 2006, 2028). It is this statement that sums up the value of user input as a mechanism that allows a multivariate, user-based approach to the design process.

How then to combine the process of information gathering, analysis, visualization and theory-building with design production itself? How can information from multiple sources – that are sometimes at odds with each other – best be obtained and processed? Can a specific context inform general situations and vice versa? Design generally involves research being applied to a creative and usually practical solution. This procedure is always iterative to an extent and involves a series of

side begins to understand the questions and issues – many of which may not be immediately evident – of the other parties. After a respectful “common ground” is created, mediation and negotiation is revealed that allows for everyone to contribute to the discussion of design and contribute their individual expertise; a principle that architects Syn Van Der Ryn and Stuart Cowan (1996) call “Everyone is a designer”. Like Lynch, Van der Ryn and Cowan respect everyday experience, decisions, and intuitions as design skills. Taking this further, they discuss knowledge of local conditions as “everything necessary to design, build, and maintain [...] places,” arguing that architectural education is flawed in that “real players and the real information are kept out of the learning,” (Van Der Ryn and Cowan, 1996, 146 ff.). A participatory process such as the design charrette circumvents this, as disciplinary languages and expertise take a back seat to shared understanding, suggesting a cultural process rather than one guided by strict expertise. It is this process that allows students to access real-life problems as opposed to self-fabricated ones.

A collaborative design charrette employed in a community-based studio project, and introduced following initial research to develop preliminary design ideas, provides opportunities for an enhanced educational experience. Community members review initial design ideas and provide feedback to the design teams during a hands-on design charrette. Assessment is immediate, as students modify projects to conform to a richness of demands and viewpoints simultaneously. A successfully modified design incorporates creativity in both the process and the product. Following ideas of process presented by Edmund Bacon as early as 1967, the charrette can assist in confirming assumptions based on research, the vision for the project and basic urban design moves; gaining input from community members on urban design goals and strategies in order to refine the project goals; and providing insight into community needs. The design charrette becomes a research tool to elicit information that will adjust design outcomes and assure socially grounded solutions.

In the urban design studio presented below, we show a revised pedagogical process that takes into account the problems and pitfalls inherent in many information-gathering and visualization processes and techniques, both for architects and for laypeople. In doing so, we have combined the concept of grounded visualization with the idea of direct user participation to explore an iterative design process that allows both research and application through design, solutions through community input, and reiteration and affirmation of the product. We explore the well-facilitated design charrette as a venue for validating research and preliminary design decisions, while building upon solutions through community input.

APPLYING THE METHOD: GREENMOUNT WEST, BALTIMORE



Student streetscape improvement studies for the Greenmount West neighborhood in Baltimore.

“Listen to every voice in the design process. No one is participant only or designer only: Everyone is a participant-designer. Honor the special knowledge that each person brings. As people work together to heal places, they also heal themselves.” (Van der Ryn and Cowan 1996, 146).

The Greenmount West project began with a thorough assessment of the area in the context of the city of Baltimore. Students were asked to consider the area’s history, defining characteristics in comparison to other areas of Baltimore, and the physical and social makeup of the quarter, both past and present. A first site visit allowed the students to document spatial features from the ground, and to gain an impression of the area’s physical and social distinctions. Parallel to this, students read a variety of texts

to introduce them to ecological, economic, and social sustainability as a theoretical framework for urban planning and design.

The students quickly realized both the area's challenges and opportunities. Once a working-class neighborhood of brownstones interspersed by a few factories and bounded by a large cemetery, Greenmount West's economic downturns had led to abandoned properties, empty lots, and an eroded social structure. The area's proximity to MICA (Maryland Institute College of Art) provided for a budding arts scene and new residents, while a Montessori charter elementary school brought in a diverse clientele from throughout the city. Resident organizations reflected this newer population, although the members expressed great sensitivity to the older residents' concerns, such as a lack of job training, neighborhood drug trafficking, and longstanding racial discrimination.

Requirements for the students' analysis were specifically framed to reflect social and economic factors in addition to physical ones. Much information could be assembled through quantitative data, such as types of businesses, location of infrastructure, and statistics gained through census reports (which unfortunately were almost ten years old). Working as a class, the students developed maps, diagrams, and charts, graphically representing the information gathered, and drawing conclusions through an active editing process. Even at this stage, students critiqued each other's analysis based on experiences or observations in visiting the site, vetting information and bringing biased assessments to the fore. Students compiled the revised proposals and accompanying visualization tools into a documentation booklet referenced by the design teams throughout the course.

In smaller teams, the students incorporated this synthesized knowledge into their proposals for the area. Five groups created five different proposals: One tied Greenmount West into an existing network of bike trails, one bridged a dividing highway to rejoin Greenmount West with amenities provided in neighborhoods to the south, one created a series of elevated walkways as a secondary web of pathways through the area, one restructured the area to create retail channels and new housing opportunities surrounding green courtyards, and one created a cultural "boardwalk" that joined MICA to Greenmount West along an existing ravine (formerly a riverbed) that contained a highway and rail lines. Students developed plans, sections and models of the area, but also diagrams to explain the various aspects of their group concepts. Political and economic feasibility was not the main issue, rather students were asked to creatively provide a "blue sky" vision for reinventing a troubled neighborhood that was showing slow signs of revival. It was with this understanding that members of community groups met with the students for a design development charrette once the tentative proposals and design guidelines were in place.

The charrette took place in Baltimore, halfway through the semester, with all seventeen students and approximately twenty community members in attendance. Students presented their analysis of the area, followed by their urban design master plan ideas. The presentation was a form of group interview, as community members were asked for their feedback on all aspects of the material presented. Community members confirmed and modified many of the student perceptions of the area, for example regarding transit use patterns and acceptance of various commercial areas (who shops where). They also pointed out further avenues for exploration, for example in describing infrastructure impact that the students had not considered, or in raising awareness of duplications, such as existing



Public presentation of student work in Greenmount West Community of Baltimore City.

venues that replicated program being proposed by a student group. In this way, students were able to confirm, adjust and build upon their own analysis, often made from quantitative data such as census information, through the qualitative observations made by the community members.

The students gathered information not only verbally – through the group interview of the community members – but also visually. After presenting the preliminary proposals for discussion, student groups and community members moved to tables, where rolls of trace paper and boxes of markers were waiting. For the next two hours, students and the community members worked hands-on and in tandem to create visual representations of the ideas that had been discussed. The design charrette allowed concepts that had been presented theoretically during the discussion phase to be translated into a modified design, with community group members setting priorities from their perspective while students used their skills in manipulating spaces to highlight the community's priorities, add desired infrastructure elements, modify spaces to better reflect transportation and movement habits, and eliminate elements for which there was no clear need.

At the beginning of the hands-on workshop each of the five student teams organized their work around a table. At the beginning of the discussion the students took a seat at the table, trace overlaying their site plan and marker in hand. Each student team was joined by at least one community member or community group representative. Although several of the guests had a background in architecture, planning, or public policy, most represented the intuitive design sensibilities that come from intimate knowledge through an engagement with place. The session began with guests politely standing over the tables while the students' tried to capture what they thought they heard on paper. In some cases community members rotated between the tables quietly taking in the scene and student responses. Within minutes, the tables were turned, or at least roles reversed, as community members took ownership of the colored markers and the proposals being represented on the tracing paper. Soon student designer and community designer were working line by line to visualize propositions, work through ideas, and strategize for the futures of their collective visions. Throughout this process, the community provided qualitative feedback and intimate knowledge as a basis for refining the designs, after which students framed new spatial and organizational options that the community could immediately review.

After the charrette in Baltimore, the students returned home, where over the next two weeks they worked out details and created more formal presentation drawings and models. The final review took place at our university, with several community members from Baltimore in attendance.

CONCLUSION: REFLECTIONS ON THE PROCESS

We found the charrette experience to have a positive impact on the studio itself. Students became reinvigorated by the procedure, and the real-life aspect of the discussions made them eager to continue with the studio project. Even if none of the projects were to be built, students felt they had become part of a greater process taking place within the neighborhood and that they were “making a difference” as budding professionals. Most importantly, they came away having learned how to reach



Students and community members collaborating during the design charrette.

out to and communicate with laypeople interested in shaping their environment. The community design experience reinforced ties with the not-for-profit developer who had introduced us to the neighborhood, but also forged relationships with community leaders and other individuals who remained contacts for the students as they developed their designs.

The studio project explored a systematic approach for information gathering and its application to design. Beginning the project with factual data collection provided the students an opportunity to become familiar with the city and the neighborhood. An early site visit allowed them to become aware of preconceptions, biases and misunderstandings or misinterpretations of data that were embedded into their initial documentation. This phase allowed students to more critically engage with information they had obtained through the internet or written documents, data that had often already been visualized in some way by others. Students subsequently vetted this information through discussions, re-evaluated and in some cases recreated facts and figures, and assembled their analysis of the data into a documentation booklet. Based on “corrected” information, students worked in groups to propose ideal visions for the community design project. By introducing public voices into the design process in the middle of the project schedule, students were exposed to a new, critical layer of both questions and information. Community members did not always speak with one voice, confronting students with a vision of multiple realities that had to somehow be reconciled. The charrette gave students an opportunity to test their ideas against the community sounding board, but it also allowed them to receive grounded feedback about information sources that would inform project development in the weeks that followed. The resulting architectural projects grew in scope and sophistication as students worked to incorporate and express various user viewpoints, in the process refining program and design intentions. With each scale of refinement, the students gained a more intimate understanding of the actual site relationships, leading to a more socially engaged and civic-minded approach in their work. Although not ideal in terms of a true integrative design process, our intention was to have the students work in teams and allow multiple opportunities for grounded feedback, in order to stress the value of iterative learning and collaboration.

Rarely is research theory brought into the architectural and urban design studio, yet it is exactly such scrutiny of process that allows us to move beyond standard pedagogical formats. Much studio research appears to be mere fact-finding, and students are often not taught concrete ways to analyze the material they find. Qualitative research is generally limited to observing action patterns or spatial uses, which amounts to a passive input from potential users. In our studio, the design charrette allowed students to explore new ways of understanding not only the problems associated with blighted urban areas slated for revitalization, but more importantly, the charrette gave the students an opportunity to reflect on their own methodologies when researching the parameters of a design problem. We interpret the design charrette, as we conducted it, as a form of “grounded visualization” – in this case an opportunity to allow the user to provide extensive qualitative material and to play an active and immediate role in setting priorities, exploring alternative solutions at different scales, and providing feedback. Our experience has been that this open-ended design approach is both more rigorous and more creative than the typical process supported largely by quantifiable data and the designer’s artistic choice.

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ENDNOTES

¹This form of charrette, also termed collaborative design, has for example become a frequent part of the process for achieving green or high-performance building standards. Many green building guidelines and certification systems either require or strongly encourage at least one project design charrette, in which multiple stakeholders are brought together to establish project goals and strategies for achieving them.

²First developed by Barney Glaser and Anselm Strauss in their 1967 book *The Discovery of Grounded Theory: Strategies for Qualitative Research* and revised by Anselm Strauss and Juliet Corbin in their 1997 book *Grounded Theory in Practice*, the research approach has been extensively described and used in the social sciences.

³User interviews about wayfinding allowed Lynch to formulate five elements of urban design — paths, edges, districts, nodes, and landmarks — based on the ways that people perceive, relate to, and remember their environments. While Lynch's text has become a landmark in urban theory, such detailed analysis of methodological process remains the exception.

⁴Michael Friendly, professor of psychology at York University in Canada, provides a concise history of the visualization of quantitative information in his interactive article, "Milestones in the history of thematic cartography, statistical graphics, and data visualization," published online at <http://www.math.yorku.ca/SCS/Gallery/milestone/milestone.pdf> (accessed 15 December 2010).

⁵While GIS is not commonly taught in architecture programs, the mapping diagrams constructed by architects and urban designers are similar, albeit less sophisticated, visualization aids. The great advantage of GIS is the range of information databases readily available for import at various scales (levels).

Action Research and Prototype Testbeds: Prioritizing Collaborative Making in Architectural Research

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ABSTRACT:

As the discipline of architecture becomes ever more concerned with the development of high performance sustainable buildings and systems requiring an increasingly complex set of interrelated and closely integrated technologies, assemblies, and material methods, the questions of what forms of research approach and what project contexts might best facilitate the advancement of related research are critical. Research methods that focus on isolated and specific aspects of building science, systems engineering, or occupant interface undertaken in the highly controlled environment of the laboratory or evaluated with simulation tools have done much to advance our understanding of individual components that might comprise the next generation of high performance buildings. However, given the complexity of integrated architectural research projects that address environment, performance and interaction, requiring multiple cycles of research and development, large interdisciplinary teams, and project cycles discordant with curricular duration, new research formats may be required. Within this context, the practices of 'action research' methodologies for interdisciplinary collaboration and the construction of physical prototype testbeds as both a focus for applied research and as living laboratories for evaluation, measurement and testing, offer a compelling pairing of practice and product. The model of action research developed by humanities and educational research teams is extended and modified to develop a format applied to architectural research projects. These strategies offer specific advantage to the architectural researcher, whose work often requires methodologies outside those of traditional scientific or humanities models, and greatly benefits from what Monica Ponce de Leon has referred to as "research through making". This paper describes the organizational and logistical context of two recent design research projects (*North House Prototype* and *The Stratus Project*) in the context of an action research framework as a means to illuminate this discussion.

CONFERENCE THEME: On Approaches: Research conceptual frameworks and their effect on forms of collaboration.

KEYWORDS: high performance buildings, architectural research models, architectural prototypes, action research, sustainable buildings

INTRODUCTION

The set of research practices known as *action research* refers to a format of research investigation in the context of applied efforts to improve the quality of an organization and its performance³. Action research typically is designed and conducted by practitioners who analyze research outcomes to improve their own practice and operational methods. (Bennett 1994) Initially focused on direct application to advancing educational practices with the goal of fostering sustained improvements in schools, it has since been engaged by a range of disciplines where the benefits of reflection on both process and outcome are structured to occur within cycles of the research project's design. Action research has been described by a range of terms, including *participatory research*, *collaborative inquiry*, *emancipatory research*, *action learning*, and *contextual action research*. Each refers to a set of cyclical practices that involve an iterative process of problem identification, action, evaluation and refinement. (O'Brian 2001)

Action research...aims to contribute both to the practical concerns of people in an immediate problematic situation and to further the goals of social science simultaneously. Thus, there is a dual commitment in action research to study a system and concurrently to collaborate with members of the system in changing it in what is together regarded as a desirable direction. Accomplishing this twin goal requires the active collaboration of researcher and client, and thus it stresses the importance of co-learning as a primary aspect of the research process. (Gilmore, Krantz and Ramirez 1986)

What distinguishes the action research approach from other research formats, and, in this context, conventional design practices, is the emphasis on systematic study informed by *theoretical* considerations. Throughout the process, emphasis is placed on refining methodological tools “to suit the exigencies of the situation, and on collecting, analyzing, and presenting data on an ongoing, cyclical basis” (O’Brian 2001). While a variety of specific process models have been articulated, (MacIsaac 1995, Susman 1983) what is of import to our consideration here are the overarching principles that underlie action research methods, and the reflection as to how this structure might re-inform approaches to architectural research techniques particular to complex design projects. Winter, (1989) outlines six principles underlying action research praxis as applied to a variety of cycle-based models of inquiry:

1. The presence of *Reflexive Critique* in evaluating the situation of the research project to explicitly reveal through reflection upon the issues and processes comprising the project and its situation and make explicit the interpretations, biases, assumptions and concerns upon which judgments are made.
2. The presence of a *Dialectical Critique* as a means to illuminate relations surrounding phenomena and context, and elements that constitute a particular phenomenon. Specifically, through this form of interrogation, emphasis is placed on identifying “those constituent elements that are unstable, or in opposition to one another. These are the ones that are most likely to create changes.”
3. Participants in an action research project are co-researchers. The principle of *Collaborative Resource* presupposes that each participant’s insights possess equal agency as potential resources in formulating outcomes and insights negotiated among the participants. This principle is intended both to challenge the structure of perceived senior authority from the prior status of a participant, and open for consideration the contradictions both between many viewpoints and within a single viewpoint
4. In research projects that explicitly seek to challenge underlying assumptions or commonly held disciplinary consensus around an issue, significant risk may be perceived by participants relative to pre-existing formal hierarchies (economic, intellectual, academic, disciplinary etc) in expressing interpretations, perspectives or ideas around a particular matter. This potential reality is identified early in the research process and work is structured with the tacit understanding that all are equally exposed through participation, and that knowledge advancement will occur equally regardless of specific project outcomes.
5. The nature of the research embodies a multiplicity of views, commentaries and critiques, leading to multiple possible actions and interpretations. This plural structure of inquiry requires a plural text for reporting. A report, therefore, acts as a support for ongoing discussion among collaborators, rather than a final conclusion of fact.
6. For action researchers, theory informs practice, practice refines theory, in a continuous transformation. In any setting, people’s actions are based on implicitly held assumptions, theories and hypotheses, and with every observed result, theoretical knowledge is enhanced. The two are intertwined aspects of a single change process. It is up to the researchers to make explicit the theoretical justifications for the actions, and to question the bases of those justifications. The ensuing practical applications that follow are subjected to further analysis, in a transformative cycle that continuously alternates emphasis between theory and practice.

From the perspective of sustainable design practice, and specifically architectural design praxis, the principles outlined above have clear affinity with the Integrated Design Process (IDP) (Busby 2007). However, in the particular considerations of action research models, inflections emerge that are particularly instructive in the academic context (in which much architectural research is undertaken), where there is explicitly greater horizontality across disciplinary participants than is structured in professional practice contexts and where research team members are also embedded within the hierarchical systems of the academy and research funding regimes. These strategies offer specific advantage to the architectural researcher, whose work often requires methodologies outside those of traditional scientific or humanities models, and greatly benefits from “research through making”. With



Figure 1: Collaborative design environments across cycles of design and making; (above) Student and faculty team discuss overarching principles during initial project workshop; (below left) Architecture and engineering students developing working drawings in the project room at the University of Waterloo; (below, middle, right) Students working on site with custom fabricators and industry partners during the build. (Team North 2009)

respect to application in the context of architectural research focussed on delivering environmentally responsive design outcomes, we propose the centrality of the development of prototype testbeds, in parallel with the implementation of action research methods for collaboration. The construct of the testbed not only offers the value to the research project of providing a physical manifestation through which to evaluate the validity and or effect of experimental proposals, but forms a physical locus around which research participant discourse is structured – capable of providing complex forms of feedback to the research undertaking.

The following sections are intended to illustrate some of the potentials of this proposition, with the hopes of structuring provisional notes towards a model of architectural action research through the discussion of two recent research projects developed by the authors that focus on team based research projects prioritizing environmental performance; the *North House Prototype*, and *The Stratus Project*.

NORTH HOUSE

The North House project was initiated in response to the US Department of Energy’s Solar Decathlon initiative, and evolved into a funded design-research project to develop a high-performance, responsive, net energy producing prefabricated prototype house specifically designed for northern climate conditions, as well as to question the ways in which architectural design can foster new forms of sustainable living. The project was selected as one of twenty finalists in the US Department of Energy’s 2009 Solar decathlon, and is a collaboration by the University of Waterloo, Ryerson University and Simon Fraser University operating with a variety of partners under the umbrella of *Team North*⁴. A goal specific to the North House is to challenge the dominant ‘good practice’ paradigm projected by benchmark and measurement metrics such as LEED, which assume that buildings with high window-wall ratios are considered to be energy inefficient. Low-energy and passive buildings, particularly in northern climates, typically do not have highly glazed facades, as windows are traditionally the building envelope components that have the least insulation value and the highest air leakage coefficient. Most energy standards restrict the window-wall ratio to 40% or less. The North House aimed to deploy recent advances in glazing technology, shading systems, thermal mass, and control systems to develop a high performance house with a highly-glazed façade (75% window-wall ratio), which, when combined with on-site solar power, can reach goals of net-energy production while radically revisiting the ambitions of transparency that underscored early modernist housing in a context of daylight deprivation in the near-north.

Within the University of Waterloo’s Graduate Architecture Program, the project has been utilized as a

catalyst to develop modes of studio and non-studio based education that have positioned architecture student participants as design team collaborators in the context of an interdisciplinary lab model over the course of an eighteen month period. Student team members participated as funded research team members, undertaking rigorous cycles of research and simulation, BIM modeling, systems coordination, prototyping, detailed design refinement, contract document production, fabrication prototyping with industry partners, hands-on training with licensed trades, manufacturing, field review, contract procurement and shipping logistics. Throughout the project, student and faculty team members worked with a variety of disciplinary experts, embedded extra-disciplinary student colleagues, industry partner collaborators, and software developers and programmers throughout all phases of the work.

WORKING PAST THE MYTH OF AUTHORSHIP

At the project's outset, student team members from Architecture, Mechanical, Civil, Electrical, Mechatronics, Systems, and Software Engineering met with faculty researchers and professional colleagues to form a team for the project and to define the primary project objectives. Criteria for design and performance were defined by an overarching set of principles and objectives that were developed with the team during a three-day workshop (Figure 1, above). In order to develop objectives relevant and appropriate to the expertise of the team, the workshop first called upon each participant to define the leading edge of their respective disciplinary perspectives and their own description of research interests that might broadly apply to the project, and then set out to describe a synthetic approach for project development that would position these objectives as both the drivers of design, performance, and systems criteria that would remain across the course of project development. The automated exterior louvers for example, which eventually became the defining aesthetic of the exterior of the North House, was the topic of a PhD thesis on external shading as a way to mitigate heat gain by one of the mechanical engineering students on the team. As a result of this process, the North House project set out to develop: (i) A *strategy* of construction and space-making for Northern Climate Extremes, capable of adaptation to regional and cultural differentiation; (ii) DReSS: a Distributed Responsive System of Skins that combines active and passive envelope

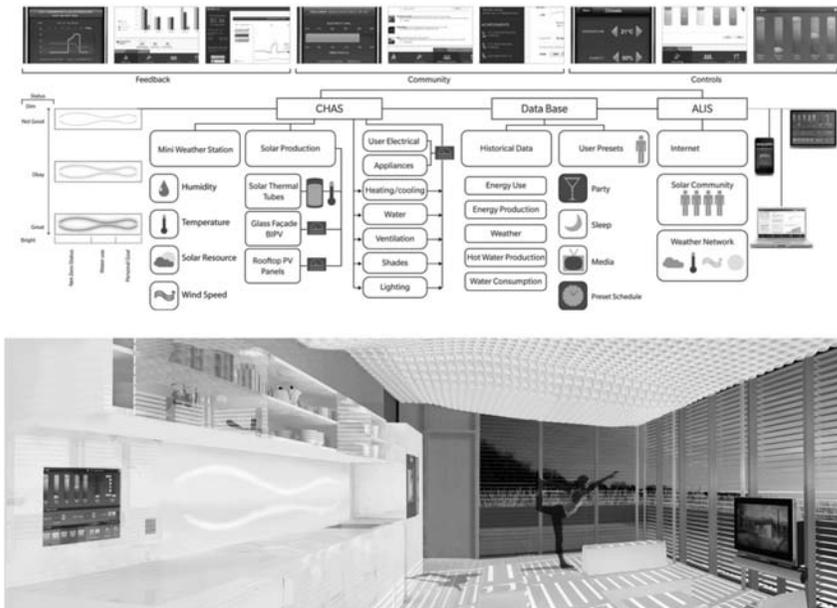


Figure 2: (above) Adaptive Living Interface System (ALIS) programming logistics, interior environments, interactive and ambient controls; (below) ALIS integrated into the North House interior environment. (Team North 2010)

technologies to result in a net-energy producing building design with a high window to wall ratio; (iii) ALIS: Adaptive Living Interface System, that combines a customized set of advanced controls with direct and ambient feedback systems intended to enhance and mediate individuals' relationships to the complex technologies and systems of the home, while fostering behavioral reinforcement of sustainable forms of occupation; and (iv) Holistic Solar Living: an ambition to develop and expand the potentials of the inhabitants' relationship to solar resources including a broad set of lifestyle enhancements, such as localized personal food production, daylighting opportunities, and robust links between interior and exterior environments⁵.

As a result of the project framework, each team member, and each team decision was governed by a set of interrelated and linked concerns marrying performance and theoretical considerations. The commanding form and materiality of the project were shaped by an aggregate set of intensive conversations and performance considerations that drove spatial configurations and component selection. Each discipline helped to shape the final form, and within the team, it was rapidly understood that each iterative inflection from the original diagram of spatialized systems was authored by the team, and remained the responsibility of the whole group. No single decision was addressed independent of performance, and so, although time-consuming, group conversations regarding the merit of each inflection directed all of the work. Detailing, of course, was weighed equally relative to form and specifications were considered relative to intent. This method is a considerable departure from traditional, or even IDP processes where the feedback and balance of such complex parameters for decision making often reside within and reinforce the authority of a 'partner in charge', or author. The primary objectives developed during the initial workshop were not only to be valuable throughout project development, but also proved essential in clearly communicating the potential sponsors, donors and granting agencies across a range of media developed as a primary objective of broad dissemination both academic and popular.

STRUCTURING ADVANCEMENT TEAMS

In order to provide structure and locus for the work, a primary project office was procured at the University of Waterloo with proximity to networked devices and the fabrication shop (Figure 1, below left). Regular and revolving meetings took place in the center of the space, bringing professional peers, team collaborators, donors, and University administrators exposing the project to a wider public – including into the core of research work and design production. Despite the fact that team members were in some instances physically separated across the various locations of the collaborating institutions, the importance of a single physical locus for design refinement was critical. Where distances were constant, a variety of communications devices produced a virtual office nested within the physical space of production. The format of project critique familiar to the design studio model, with specific emphasis on actions, follow-up activities or the suggestion of lateral or parallel probes in the work was utilized on regular cycles in focused team groups to advance materials research, energy modeling, and design advancement. Design decisions and material evaluations were undertaken within these contexts, with student team members presenting proposals for concentrated review with design faculty and team members from other disciplines in order to ensure that a full spectrum of concerns were considered at each junction. Visiting professional engineers, industry partners, and manufacturer's representatives also provided feedback on the project, its detailing, and assemblies during these sessions.

An early team visit to the Toyota Motor Corporation production facilities in Cambridge, Ontario (intended to foster appreciation of Mass-Customization or Delayed Differentiation techniques within the project's potential modes of fabrication) introduced the concept of "Kaizen" – or continuous team performance improvement through the incremental implementation of all team member's initiatives to improve process and product. For example, the students' internalization of distributed social networking systems was legible, and constantly offered more senior team members a window into team organizational logics beyond those of our own experience - we would often witness several remote team members collaborating within compressed timeframes toward specific material solutions with virtual tools, yet still capable of maintaining constant informal contact as would those working in close physical proximity.

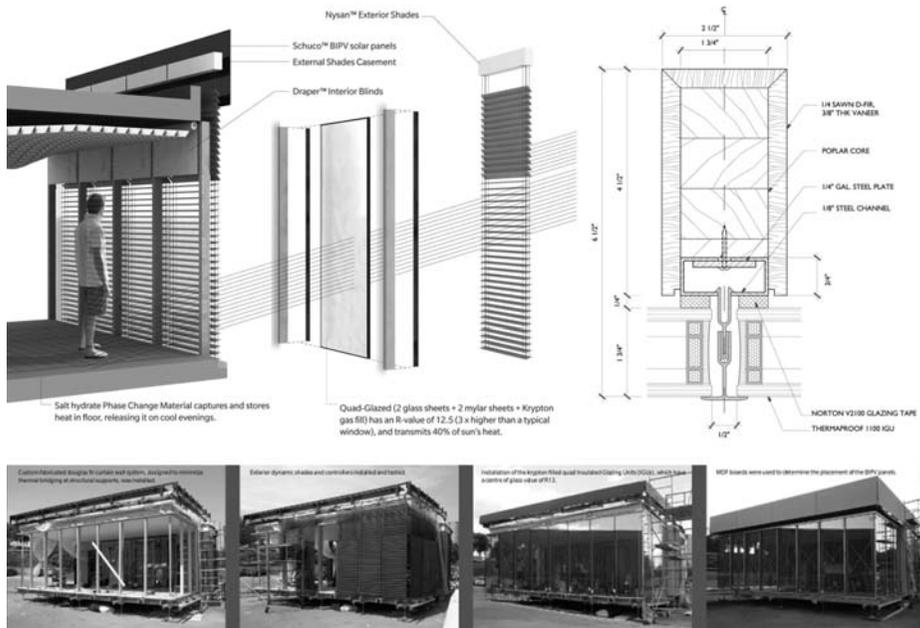


Figure 3: (above, left) Responsive Envelope System components; (above, right) Highly insulated wood curtainwall mullion detail; (below) responsive shading and glazing system during assembly. (Team North 2010)

EXPANDING DISCIPLINARY BOUNDARIES

In order to manage the complexities of the project, specific project component teams were developed to bring to bear a range of disciplinary perspectives on particular aspects of the project. These included teams that focused on glazing and active shading envelopes, structural assembly chassis and details, BIPV integration, HVAC systems, controls and sensor systems. However, each team was required to interface simultaneously with each interrelated team and system so that all components could be successfully integrated and so that incompatibilities and conflicts could be minimized in the built and operational prototype.

Of particular interest, was the development of the project's complex automated controls and human-digital interface systems. Architectural students and faculty found themselves consulting on the development of controls software and interface systems. This student team, consisting of graduate students from the architecture program, the school of interactive arts and technology, mechanical and systems engineering, computer science and sustainable systems programs, worked through an intensely collaborative process to develop advanced controls systems with a digital graphic user interface, web, and smart phone application. While this work was coordinated and executed in partnership with industry partners Vertech Solutions and Embedia Controls, it was interesting to note the former work experience that was brought to bear by student team members including mature students, a retired project manager from Research in Motion (RIM), and a student who had directed product development within the biomechanical industry. The architecture students found themselves being educated in engineering and computing discourses and had to learn to navigate through design discussions that typically do not occur within our school of architecture. It is hoped that this type of collaboration might become more common in architectural design programs, as sustainable and high performance architecture increasingly embraces advanced technologies and automated systems.

The Adaptive Living Interface System (ALIS) developed by the team responds to the project ambition of enabling occupants to relate to the suite of advanced technologies and mechanical systems that govern the performance of the house. This is achieved primarily through the architectural integration

of ubiquitous computing technologies that provide feedback and ambient cues when user-activated changes affect energy performance-prioritized presets. The three components of the ALIS system consist of: building integrated touchscreen displays for setting of user preferences and automated systems; an iPhone application that provides statistical feedback on energy and water use related to costs, as well as links to online communities to foster further sustainable lifestyle patterns; and a pattern of solid state lighting integrated into one of the interior building surfaces that provides ambient and haptic feedback. The direct collaboration with systems engineers, interactivity designers and building controls has been a uniquely valuable experience for all involved and significantly transformed the resultant space of the house. (Figure 2, below)

The development of the building envelope introduced a broad range of technical and aesthetic variables into discussions that prioritized the design synthesis as a project goal. The goal of developing a 'responsive envelope' (Figure 3) as one that could mediate changing environmental conditions, rather than providing a static response to anticipated conditions, became a major focus within the subtle feedback on energy and water use.⁶ (figure 2, above) Early energy modeling supported the project's challenge of conventional envelope best practices and had made the case for large areas of high performance glazing coupled with active shading systems that could support passive heat gain to phase change materials (salt hydrate packets) embedded within the interior assemblies of the building. The process of selecting individual IGU elements, coating for each face of this system, individual glazing tape types, spacer bar materials, mullion spacing and the like went through a rigorous process of digitally modeling each system and element configuration to evaluate its implications within the overall envelope system (quad glazing utilizing mylar films with selective UV coatings was eventually deployed). The final configuration of mullion spacing, wood curtainwall cross sections, fastener-less nylon glazing caps, exterior venetian blinds and interior shades were determined within a complex matrix of dimensional logics, performance evaluation, and proportional concerns. The resulting system has been designed to outperform anything currently available commercially within the local market. Digital tools were utilized to not only anticipate and evaluate energy and thermal performance of this system, but to evaluate carefully the appearance of these systems. Student teams undertook energy modeling, three-dimensional digital modeling and visualization activities in parallel constantly tracking the implications of performance with respect to appearance, and daylighting levels.⁷

PROTOTYPE TESTBEDS VS DESIGNBUILD

Across North American schools of Architecture, many initiatives are underway that prioritize relationships between thinking and making – design and production as a means to transform the role of studio teaching in the education of an architect. Within the North House Project, it has been the synthetic approach to the implementation of collaborative structures and ways of working that has been of the most profound impact. This is perhaps most evident in the several ways in which students' relationship to making and building itself have been cultivated. Rather than the prioritization of one method over another, the project embraces several modes in parallel, as appropriate to team member skill sets, available resources and quality objectives.

During construction of the prototype building by MCM 2001 Inc., student team members were embedded at the factory where each component of the project was produced on the shop floor, fitted, tested and finished prior to being assembled on the prototype proper, an activity which also occurred on the site of the professional fabrication shop. Contrary to traditional models of project document, production and procurement, detailed drawings were produced in advance, during and after production. Each component of the construction went through several cycles of development, first informed by the inclusion of energy performance and digital modeling integration, then by the exigencies of the fabrication process and material realities. During the production of prototypes, (both by professional fabricators and team members), knowledge acquisition was understood to be transferred regardless of the hand's relation to the work. In this case, it is not the lessons derived through the researcher's direct physical relation to the creation of the artifact through their labor that is prioritized (as with design build programs of creative research), but rather, their contact with advanced processes that shape the project's delivery and its realization regardless of manufacturing format.

OUTCOMES

With respect to the research outcomes of the North House project, the benefits of an action research methodology and testbed utilization are multiple. First, the dedication to the project by its team members was undoubtedly amplified by the strategies achieved through participatory buy-in and responsibility for decisions and outcomes created by the process. Second, the range of unique technical solutions (building envelope, kinetic shading systems, system performance and ALIS occupant interface system) were without question radically different in outcome and performance than had they been developed within traditional silos of disciplinary responsibility. Further, the complex synthesis between these systems and their tectonic resolution was indicative of the high level of commitment and responsibility that the lead students took on relative to the finished product and its performance. Although learning in action research would have occurred regardless of the project outcome, the project performed extremely well during the Solar Decathlon competition,⁸ and has been since recognized by a range of awards, agency support and dissemination formats.⁹ At the time of submission of this paper, fundraising efforts remain ongoing to reassemble the prototype in order to facilitate long term occupancy testing.

THE STRATUS PROJECT

As both an extension of, and departure from, the whole building performative and environmental demands of the North House project, the Stratus Project is an interior-environment modifying apparatus which aims to bring our attention to the immediate air-based environment and the conditions that produce it. Similar to the initiation of the North House project, Stratus began with intensive meetings around disciplinary positioning, and in particular, on the relation between the 'soft' architectural projects of the 1960's and 70's, and their relation to new formats of responsive environmental production enabled by recent advances in computational capacity and ubiquitous intelligent environments. Preliminary discussions between interested research participants involving students and faculty from Architecture, Mechanical Engineering, Industrial Design and Computer Science proposed to bring together two emerging areas of architectural concern – atmospheric design and responsive architecture – to develop a light and air-based architectural environment that utilizes new sensing technologies and distributed systems to harness energy and movement flows tempered through occupant-responsive feedback in defining envelopes of intimate and collective space. The work seeks to investigate how new forms of digital manufacture, embedded sensors and dynamic controls systems informed by user feedback and kinetic energy-producing surfaces might engender an environment based upon the prioritization and rendering legible of the often intangible aspects of architectural environments: temperature gradient, luminosity, airflow, humidity and atmospheric effect. (figure 4)

The project anticipated from its inception that it would be comprised of a distributed system of components, elements and operations that behave through controls-linked interdependence to perform in aggregate, and so the work began with two primary scalar streams of investigation; *network* and *cell*. The two streams of intensive work were developed first, in parallel, and then were combined into a prototype responsive system. Ambitions for these systems were defined in aggregate consensus by team members; (i) that the material form of the project would produce phenomenological effects sympathetic to the atmospheric ambitions of its theoretic underpinnings, (ii) that the system's spatial configuration would embody both gross motor reconfiguration in response to occupant presence and localized deformation in response to air quality sensation and human presence, (iii) that all formal characteristics of the system would be governed by the limits of manufacturing logistics and material properties rather than predetermined formal conceits and (iv) that visualization and simulation of the project would be prioritized in its development and in the context of a seed project to both develop didactic communications regarding the project's characteristics, and as a vehicle towards future project phases.

ITERATION | LATERAL MOVEMENT | PROTOTYPING

Several streams of research informed directly by physical prototyping in parallel with digital design processing informed the early development stages of the first of several anticipated iterations of the Stratus project. V1.0 investigated the potential of tensegrity-based structural systems relative

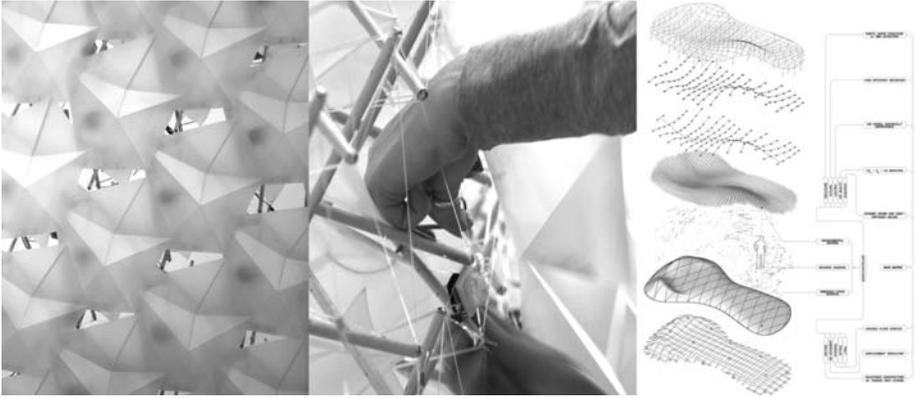


Figure 4: (right to left) Preliminary systems diagrams incorporating displacement ventilation raised floor assembly. Rigging the tensegrity framework. Die cut actuated cells assembled. (RVTR 2011)

to physical reconfiguration in space actuated via occupant sensing, the development of cellular baffles to control air movement, the incorporation of phase-change coated fabric membranes to maximize surficial area and absorption potential within the system, the development of low energy distributed micro fans to condition sensible temperature variation, and affect air extraction based upon ‘contaminant’ sensing of VOC’s and CO2 levels. (figure 5) As with the North House project, the specific pre-existing research interests of the team shaped the development of the first prototype system, yet were tempered through team discussions and material and technological resistances as well as external constraints (budget, material embodied carbon values, limits of commercially available components for prototyping etc).

For the participants in the Stratus team, the value of a short period of intensive investigation into somewhat unfamiliar disciplinary territory has been of immense value in helping to not only identify clearly frictions illuminated through the physical prototyping process, but through the development of shared language and practices that juxtapose areas of assumed disciplinary familiarity relative to naivety. The advantages of the interdisciplinary discourse around this modest research project positioned within the context of equality prioritized by action research methods has again, as in the case of the development of the advanced systems of North House, produced unexpected outcomes, and a new appreciation for extra-disciplinary voices in the shaping of architectural research projects. Apparent disadvantages and frictions in development prototyping have become project leitmotifs as opposed to conditions to be overcome. The contributions of more junior team members in shaping the project have been significant relative to projects structured outside the tacit horizontality of action research structures, and through the undertaking of an intensive short first phase involving physical prototyping, a range of issues and questions have emerged in the near term of this undertaking that already prioritize a set of concerns and questions not clear in terms of their relevance at the on set of the project. At the time of this paper preparation, the first fully operational prototype is being completed for demonstration in a public context.

PROJECTIONS

The intention of this paper is to illuminate the potential for action research principles relative to the conception and structuring of architectural research projects, particularly in the context of full-scale testbed constructions, through the experience of recent projects – one completed and one in motion. While the development of practice based processes aimed at advancing environmentally responsive and sustainable building design such as IDP may engage mechanisms towards inclusive interdisciplinary research models, they remain structured in the realms of practice as opposed to the primarily academic domains of research inquiry. Further, we contend that central to the adoption of these practices in the development of research projects involving complex interrelations between environmental and occupant responsiveness, that the development of prototype testbeds is critical

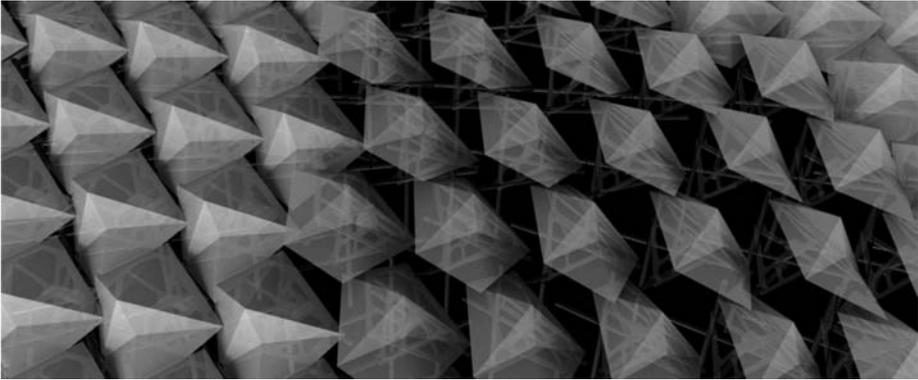


Figure 5: Stratus Project, breathing cells differentially actuated to facilitate responsive airflow. (RVTR 2011)

in advancing related research agendas. Implicit in the action research model is the value placed on structuring processes of knowledge transfer and exchange between participants as not only a byproduct, but a central aim of the research method. In the context of academic research, the links between this set of structures as both a catalyst to new models of research projects and new formats of learning may be instructive. Several fundamental and perhaps rhetorical questions remain with respect to the adoption of action research modes of inquiry as a model for architectural research; (i) Are we disciplinarily willing to accept the questions and interests of a broad constituency of team members as representative of societal concerns in structuring and defining research objectives? (ii) Does the implicit role of learning among team members prioritized by action research models have a place in serious architectural research? (iii) Will the extended timelines for research projects necessitated by the inclusionary nature and iterative processes dictated by action research models be accepted within the constructs of disciplinary research structures? (iv) Will funding agencies be willing to accept the nature of proposals that describe expanded teams and related costs in structuring grant conditions and budgets relative to existing humanities or scientific based models? The authors of this paper are hopeful that these questions are of value to colleagues and may contribute to emerging discussions surrounding the structuring of architectural research poised to engage the development of high performance sustainable buildings and systems that necessitate ever more complex teams, questions and objectives.

ACKNOWLEDGEMENTS

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ENDNOTES

³The overview of action research methods outlined in the paper's introduction is based on the structure of a literature review and synopsis of dominant action research perspectives authored by O'Brian in 2001 and cited above.

⁴All drawings and photographs of North House courtesy of *Team North* and RVTR. For a full project description, general project overview, please visit www.team-north.com For a complete listing of project credits and participants, see www.rvtr.com/rvtrWeb/TEAM_NORTH_CREDITS.pdf

⁵For an extended discussion of the principles of holistic solar, see Velikov and Thun, "Contemporary Critical Regionalism and the Emerging North" 2008 *Conference Proceedings of the Society for the Study of Architecture in Canada*, and Velikov and Thun, "Complex Collaboration as a Lever for Design Research Innovation" *Deep Matters: 2008 AIA/ACSA Teacher's Seminar: Cranbrook Academy of Art, Bloomfield Hills, MI* (online proceedings), and for a description on the environmental performance outcomes of the North House project, see: Velikov and Thun, "Mass-Customized Prefabricated Solar Residential Prototypes for Northern Climate Applications" in *ISES RE2010 Renewable Energy 2010 Proceedings*, Yokohama: ISES, O-Ps-1-3.

⁶for a detailed discussion of the technical design and theoretical positioning of the ALIS system and its links to sustainable building usage through the lens of behavioural psychology, see Velikov and Bartram, "North House: Developing Intelligent Building Technology and User Interface in Energy Independent domestic Environments," *PLEA Annual Conference 2009 Proceedings*

⁷for a detailed discussion of North House envelope modelling and glazing system design and performance metrics, see Lee, I.Y.T. et al. (2010). "High Performance Facades for Heating and Cooling in Northern Climates", *International High Performance Buildings Conference*, West Lafayette, IN, July 12-15

⁸for a detailed description of system performance and interaction during the Solar Decathlon competition based on data-logger records, see Saeid, T. et al, (2010). "Compact Integrated HVAC System for a Net-Positive Energy House for a Northern Climate", *International High Performance Buildings Conference*, West Lafayette, IN: July 12-15

⁹The *North House* project has been exhibited as part of the 2008 Young Architects Award program at the Urban League in NYC, the 2009 Twenty+Change Canadian Design Awards program. It was awarded a 2010 Design Excellence Award from the Ontario Association of Architects, a 2010 R&D Award of Excellence from Architect Magazine, and a 2011 RAIC Award of Excellence for Innovation in Architecture.

Spatial Layout and the Promotion of Innovation in Organizations

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ABSTRACT:

Research on the enabling factors of innovation has focused on either the social component of organizations or on the spatial dimensions involved in the innovation process. But few have examined the aggregate consequences of the link from spatial layout to social networks to innovation. This paper reports preliminary data from a larger study that explores the role of spatial layout as it interrelates with social networks to promote innovation among scientists and engineers working in two very different research-intensive organizations, a non-profit life sciences institute dedicated to translational research on cancer and at one of the research labs of a multinational software corporation. The study applies space syntax analysis to map and characterize physical space in conjunction with survey data capturing social contacts among researchers at the two organizations.

Social networks play important roles in structuring communication, collaboration, access to knowledge, and knowledge transformation. These processes are both antecedent to and part of the innovation process. Spatial layout structures patterns of circulation, proximity, awareness of others, and encounter in an organization. These interrelationships become fundamental to the development of social networks, especially those networks critical to the innovation process.

This paper focuses on the role of spatial layout as it affects innovation volume and impact at the individual level. Our methods of spatial analysis provide the opportunity to examine potential effects of spatial layout at both the local and global levels.

This study extends our understanding of the complicated organizational, social, and physical correlates of innovation. Results support our understanding of the effects of spatial layout innovation outcomes. We hope to identify opportunities to guide the social and organizational structure and spatial layout of workspace to create more effective, efficient, and innovative organizational processes.

KEYWORDS: organization theory, innovation, spatial analysis, workspace design

INTRODUCTION

This paper reports on preliminary results from a portion of a larger study that examines the joint effects of social networks and spatial proximity on innovation. Research on the enabling factors of innovation has focused on either the social component of organizations or on the spatial dimensions involved in the innovation process. But few have examined the aggregate consequences of the link from spatial layout to social networks to innovation. This project enriches our understanding of how organizational innovation works by exploring the social dimensions of innovation as they are embedded in a specific spatial milieu. This project, funded by a grant from the NSF¹, is by its conception, interdisciplinary. Our interest is to bridge disparate disciplines, and their respective bodies of knowledge, to explore the social dimensions of innovation as they are embedded in specific spatial milieu.

The research focuses on scientists and engineers working in two very different research-intensive organizations: a non-profit life sciences institute dedicated to translational research on cancer and at one of the research labs of a multinational software corporation. We employ the methods of space syntax to map and characterize physical space with survey data capturing social contacts among researchers.

We investigate the associations between innovation within these organizations and the organization's social structure, as revealed through its social networks. Social networks play important roles in structuring communication, collaboration, access to knowledge, and knowledge transformation. These processes are both antecedent to and part of the innovation process.

As built space structures patterns of circulation, co-presence, co-awareness and encounter in an organization, these interrelationships become fundamental to the development of social networks, especially those networks critical to the innovation process. In particular, this paper explores the contributions to innovation outcomes of various approaches to the in-depth analysis of space as represented by alternative methods of space syntax analysis.

The techniques for the analysis of spatial form or "space syntax analysis", developed by Bill Hillier and his colleagues at University College London (Hillier & Hanson, 1984), provide rigorous methods of measuring both global and local spatial network characteristics and relationships between them (Peponis and Wineman, 2002). Principles of spatial organization affect the generation and distribution of movement patterns in space, space use, and the ways in which occupants encounter others in space (Hillier and Penn 1991; Peatross and Peponis, 1995; Peponis, 1985).

One of the exciting aspects of syntax analysis is the opportunity to explore quantitative representations of space. Different syntax methods focus on different characteristics of space and are therefore more or less appropriate for quantifying alternative aspects of spatial layout. For example, 'lines analysis' describes spatial layouts as lines of physical access, where longest lines are drawn that cover all potential paths of access on a plan, and can be applied to either urban layouts or building plans. One of the advantages of these approaches to the representation of space is that, once the approach is selected and applied, we can quantify relationships among spaces at both the local level and the global level for each spatial system.

BACKGROUND

This paper examines the comparative contributions of three alternative ways to characterize physical space as represented in syntax analysis: lines analysis, convex analysis, and visibility analysis. Hillier and Hanson (1984), in the development of space syntax analysis, described their work as dealing with topological and numerical parameters, and propose measures of accessibility that are functions of the number of direction changes made, the number of boundaries crossed, or the number of spaces traversed. In this early work, metric distance was explicitly not factored in the measures. Syntax analysis involves the translation of a two-dimensional spatial layout into a graph. Where a graph consists of a set of nodes, or vertices, and a set of lines, or edges, and each line makes a link between two of the nodes of the graph.

The most socially significant properties of space evoked in the literature of "space syntax" can be stated in graph theoretic terms. "Depth" characterizes the relationship of a node to the graph that contains it. The depth of a node is the sum of the lines that are necessary in order to reach all other nodes in turn. "Integration" is the major graph-based measure used in the "space syntax" literature. Integration is an algebraic function of the mean depth of a node from all other nodes in a system. In this sense it is a measure of the interrelationships among spaces for the entire spatial system at a global level. "Connectivity" refers to the number of links associated with a given node, it is, in other words, a simple and very local measure of connection. Similarly, we can look at a more localized measure of integration, by calculating mean depth for only those nodes in the immediate vicinity of a node (typically for a local measure of integration (integration₃) the calculation is limited to nodes that are three nodes from the origin).

In principle, the question of the definition of distinct spaces can be addressed separately from the graph-based part of the theory. For this paper we will explore convex analysis, lines analysis and visibility analysis. From any given position, our sense of space is characterized by the convex area that contains us as well as the lines of potential movement or visibility that direct us to other convex areas beyond. To capture the underlying spatial structure that is associated with movement, space syntax analysis represents spatial layouts as sets of intersecting lines. The "axial map" or "linear representation" (Hillier and Hanson, 1984) comprises the fewest and longest lines that are needed

in order to cover all the ways of moving around a layout and in order to reach all the spaces. Our prolonged occupation of a space is associated with our sense that there is a region of space within which we are located and to which we have reciprocal visual access to others located within that space (we see them, they see us). Both intuitions can be linked to the idea of convexity. The “convex map”, which comprises the fewest convex spaces that are needed to cover a layout, was proposed as an appropriate method for identifying two-dimensional spatial units (Hillier and Hanson, 1984).

Another definition of distinct space is the visual field or visual “isovist.” The “isovist” (Benedikt, 1979) comprises all the area that is visible around a particular position and offers us a way to study plans in terms of visual fields. Movement and prolonged occupation are fundamental poles of our experience of space. Seeing beyond the present position in some particular direction is an aspect of how movement is possible. To capture the underlying spatial structure that is associated with movement, layouts can be represented as sets of overlapping visual fields. On any given layout plan, a great many different isovists can be drawn, and in order to fully analyze the layout a convention must be followed to decide where the isovists can be rooted. One convention is to cover the plan by a square grid of a given size, as if to “tessellate” it, and then to draw one isovist from each square unit (Batty, 2001; Turner, Doxa, O’Sullivan & Penn, 2001).

The convex spaces that can be occupied, the lines along which we can move, and the visibility polygons that are available to us are three fundamental ways in which we may interpret plans as discrete patterns of relationships (see Figure 1).

METHODOLOGY

For each of our two study organizations, the life sciences institute and the software company, we apply each of the three spatial analysis approaches to understand their relative contributions to predicting our innovation outcome measures. We emphasize two key aspects of the discovery process; the ability to access new ideas by conscious search or serendipity (*prospecting*), and the ability to activate colleagues’ support to validate and promote those ideas, or *mobilizing*. Both are activities that can be nourished by social network connections or encounters in physical space, or some combination of the two.

For these two organizations we use two measures of innovation: patent applications and publications.

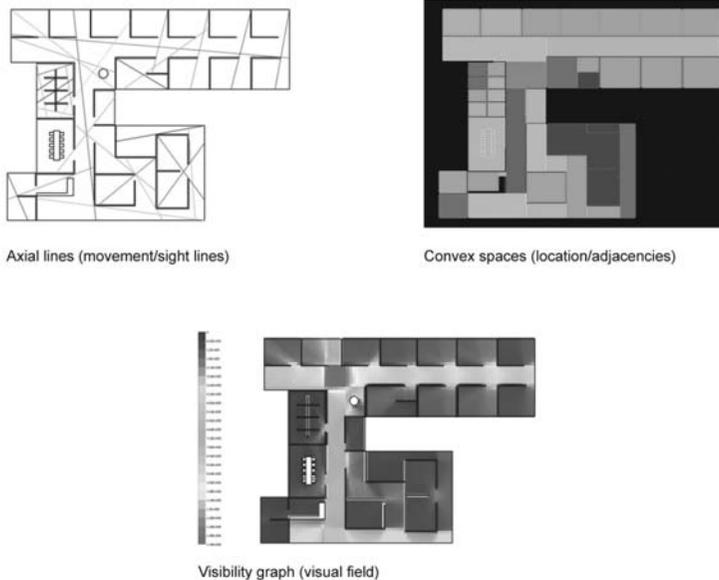


Figure 1: Convex Analysis, Lines Analysis, and Visibility Analysis

All professional personnel in each of our study populations were asked to complete a social network survey. This survey collected sociometric data on the nature of the relations between the professional colleagues in the groups or departments of interest. Given the multidimensionality of our innovation research, we will explore networks that reflect the collaboration networks of actors as well as the strength or importance of these collaborations.

We analyze the workplaces of our research sites in terms of spatial design characteristics by applying space syntax analysis to the floorplan layouts. The three approaches to syntax analysis, convex, axial, and visibility analysis (as described above), are compared in this paper. Thus, we will be looking at how accessible the spaces are, and what kinds of visual relationships exist amongst different areas. Using space syntax software we calculate two measures for each of these analysis methods, *integration* and *choice*, and examine each of these measures from the scale of the layout as a whole (global) to the scale of individual spaces and work groups (local).

We argue that network positions and beneficial office locations influence workers' ability to prospect for new ideas and mobilize the resources and attention necessary to implement those ideas. In particular, we examine how *proximity* (as measured by the variable integration) and *inescapability* (as measured by the variable choice) influence the rate of innovation.

Spatial Proximity and Inescapability. There appear to be few substitutes for face-to-face interactions in knowledge intensive work. As physical distance increases, the likelihood of collaboration decreases (Olson and Olson, 2000). Olson et al. (2002) report that radical collocation doubled the productivity of software engineers by increasing the team's ability to monitor and learn from one another's work. Early studies exploring the link between space and work processes focused on the effects of linear or geometric distance on processes such as communication. Allen (1977) showed that the probability of communication between engineers dropped precipitously at the 30 meter mark. Allen's work was also seminal in suggesting that other physical aspects of the pathway between individuals, such as doorways and stairs (barriers) or turns in the corridor (topologic characteristics), extended the perceived 'distance'.

The importance of proximity (integration) is not limited to one's local work group. As Allen indicates from his studies of engineers, the most powerful ideas were reported to develop not from communication within the workgroup, but through communication beyond the workgroup with others in the organization. So we see proximity operating at two levels, the local level encompasses links to colleagues in one's immediate vicinity, and the global level identifies links that connect individuals across areas of the organization.

Hypothesis 1: As proximity to colleagues increases, the rate of innovation rises.

We have suggested previously that a good idea is not the sole ingredient for innovation; but an individual must coordinate and mobilize a collective effort to bring these new ideas to innovative outcomes. Thus, an important aspect of innovation is the process of mobilizing collective effort. If an individual comes into contact with many colleagues, and in particular those that are from across the organization, he/she would be more likely to be successful in this process of mobilization.

In exploring how spatial layouts connect individuals across the organization, it becomes clear that particular layouts of corridors and offices can tend to concentrate movement along a few main corridors, or distribute movement across multiple access routes. The extent to which the layout concentrates use will affect the likelihood that any individual will serendipitously encounter others in the organization. The measure of 'inescapability' (choice) captures this concept of a corridor or other locations that concentrates use. If alternative routes do not exist, individuals do not have a choice, but must pass through this location, bringing them into contact with other users of that location.

Hypothesis 2: As proximity to locations of 'inescapability' increases, innovation rises.

FINDINGS

Regression models were applied to examine the contributions of background variables (job type, status, PhD degree, previous patent applications/publications), social network power and prominence, and

spatial proximity (as measured by the variable *integration*) and inescapability (as measured by the variable *choice*) to innovation outcomes (publications, patent applications).

Results indicate significant contributions of spatial proximity (integration) at both the local and global level to outcome measures of both publications and patent applications.

Spatial proximity as measured by convex space analysis generally provided stronger contributions than the measure based on axial analysis. Visibility analysis did not provide strong explanatory power.

No significant contributions were found for spatial inescapability (choice).

SOFTWARE COMPANY

At the local (workgroup) level, the more one is located in close proximity to other work colleagues, the more likely s/he will publish. We have significant results for convex integration ($r= 1.83, p<.05$).

At the global level, the more an individual is located in close global proximity to others in the organization, the less likely they will publish. We have significant results for convex integration ($r= -5.32, p<.05$) and axial integration ($r= -2.08, p<.05$).

There is a significant but weak relationship with visibility (calculated for the local floor area). To the extent that one is more visible to colleagues on the floor, s/he is less likely to publish (visibility integration, $r= -.57, p<.01$).

For this organization, we also find contributions of our syntax measures to explaining patent applications. At the local (workgroup) level, the more one is located in close proximity to other work colleagues, the more patent applications s/he will likely submit. We have significant results for convex integration ($r= 3.21, p<.01$).

At the global level, the more an individual is located in close global proximity to others in the organization, the fewer patent applications they will likely submit. We have significant results for convex integration ($r= -3.39, p<.10$) and axial integration ($r= -3.54, p<.05$).

LIFE SCIENCES INSTITUTE

For this organization, the only spatial predictor of the likelihood of publication is at the local level; the relationship is significant but weak. At the local (workgroup) level, the more one is located in close proximity to other work colleagues, the less likely s/he will publish. We have significant results for axial integration ($r= -.86, p<.05$).

The only spatial predictor of patent applications is at the global level. The more an individual is located in close global proximity to others in the organization, the fewer patent applications they will likely submit. We have significant results for convex integration ($r= -9.95, p<.10$).

There is a significant but weak relationship with visibility (calculated for the local floor area). To the extent that one is more visible to colleagues on the floor, s/he is less likely to submit patent applications (visibility integration, $r= -.72, p<.10$).

In sum, the literature suggests that there appear to be few substitutes for face-to-face interactions in knowledge intensive work. As physical distance increases, the likelihood of collaboration decreases. Olson et al (2002) showed that radical collocation doubled the productivity of software engineers by increasing the team's ability to monitor and learn from one another's work. However, for these two particular organizations differences in their focus, scientific orientation and mission appear to support very different results.

For the Software Company, results support the importance of close spatial proximity (local) for both publications and patent applications. The results are tentative for the Life Sciences Institute, but local *proximity* seems to work against publication. For both of these organizations, people whose physical locations put them in close spatial proximity (globally) with colleagues across the organization were not at an advantage for either publication or patent applications. Thus at the organizational scale, we did not see spatial proximity fostering the ability to mobilize individuals across the larger organization, an ingredient we hypothesized as integral to bringing new ideas to fruition.

CONCLUSIONS

Our preliminary findings demonstrate how physical space (proximity and inescapability) influence the rates at which scientists and engineers working in different research-intensive organizations innovate. Differences between types of innovation (patents and publications) and variation in the focus, scientific orientation and mission of the organizational settings allow us to examine how physical space effects on innovation are shaped by broader institutional contexts. Thus, we suggest that innovation is a process that occurs at the intersection of social and physical space and that the relationships between salutary network positions and beneficial locales themselves derive from institutional contexts that shape the priorities, opportunities, goals and practices of discovery.

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ON MEASUREMENT

The effect of spatial knowledge on sense of belonging in university/academic environments

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ABSTRACT:

The simple task of navigating from one point to another involves multiple functions and is more complex than it appears to be. In order to travel from one point to another, a person employs different types of knowledge, defined as spatial knowledge, which facilitates the ability of wayfinding. The ability to acquire spatial knowledge can be enhanced by increasing the imageability of the environment. This environmental characteristic could be linked to an important human behavior, the sense of belonging, the feeling of belonging to a group or a place. Previous literature has reported the significance of sense of belonging for psychological, social, and physical well being. A higher level of sense of belonging to a place can yield valuable results especially to an academic environment such as achieving better academic standing, closer relationships with peers, and elevated self confidence. Since sense of belonging deals greatly with the surrounding environment, it is necessary for educational facilities to have unique design characteristics to increase the different levels of spatial knowledge. This study focuses on the impact of spatial knowledge for a university campus on sense of belonging among college students. The study was conducted on 63 undergraduate students from the Department of Architectural Studies in University of Missouri. An eight-point likert scale questionnaire was devised to measure the college students' level of sense of belonging to University of Missouri and their Spatial knowledge on the university. Identifying the relationship between spatial knowledge and sense of belonging relates to understanding the connection between university students and their environments. This knowledge will prove invaluable in providing the ideal academic environment by creating settings for students which are more imageable as well as navigable. It was found that landmark and route knowledge were significantly predicting sense of belonging. Further findings were discussed in the paper.

CONFERENCE THEME: Social paradigm

KEYWORDS: Sense of Belonging, Spatial Knowledge, Imageability, Wayfinding, Academic Environments

INTRODUCTION

In order to travel from one point to another, a person employs different types of knowledge such as Landmark, Procedural (Route) and Survey, which as a whole is defined as spatial knowledge. Spatial knowledge facilitates the ability of wayfinding and the ability to acquire spatial knowledge can be enhanced by increasing the imageability of the environment. This environmental characteristic could be linked to an important human behavior, the sense of belonging. Sense of belonging refers to the feeling of being part of a group or a place. The main hypothesis of the study is that the increase in the amount of spatial knowledge will trigger an increase in sense of belonging to that place. Our belief that higher level of spatial knowledge creates familiarity with the environment makes people feel attached to this environment and being part of it. Since sense of belonging leads to great benefit in the educational field, it is necessary for educational facilities to foster sense of belonging in students.. The aim of the study is to explore the impact of spatial knowledge on sense of belonging of university students to increase the students' academic performance through architecture.. Our main hypothesis in this study is that this fostered sense of belonging to that environment is a result of the spatial knowledge that the users can absorb through that environment.

LITERATURE REVIEW

SPATIAL KNOWLEDGE

Finding ones way through space has been given considerable attention through the years. The simple task of finding the path from one point to another involves multiple functions and is more complex

than it appears to be. The words wayfinding and navigation are often used to describe the process of moving through space which includes complex cognitive processes as well as physical muscular movements. Knowledge about the space (or spatial knowledge) which one occupies becomes a very important factor in this process. People acquire spatial knowledge by moving through an environment, by viewing maps and through simulated media (video, slides, and virtual environments). Spatial knowledge provides the essential information which is required to navigate through an environment, and it also provides the information needed to approximate ones bearings within that environment.

Spatial knowledge has been categorized into three types of knowledge's: landmark knowledge (knowledge about landmarks, a single point in space), route or procedural knowledge (knowledge about a sequence of points), and survey knowledge (knowledge about the spatial relation of at least two points) (Bruner, 1988; Piaget & Inhelder, 1967; Siegel & while, 1975; Thorndyke, 1981). Wiener et al. (2009) identifies these categories and organizes them as three levels of spatial knowledge; knowledge about the location of a specific goal, knowledge about a specific path toward a goal, and knowledge of the environment as a whole. The three main components, landmark, route and survey knowledge together which what is called spatial knowledge, provides the user the ability to navigate through an environment efficiently. Increasing these three components, especially landmark and route knowledge provides legibility and imageability to the environment (Lynch, 1960) and when an environment becomes more legible and navigable to the user it becomes easier for them to foster a sense of familiarity to that environment.

Thorndyke et al. (1981) operationalizes the spatial knowledge of users giving consideration to landmarks in the environment, using judgment of orientation, location, Euclidean distance between landmarks, and route distance along city streets between landmarks. In experiments using film as a medium for simulating movement through an environment, Craik (1968) measured subject's spatial knowledge using place recognition tests, and questionnaires of landmark, context and location. Cohen (1980) exposes subjects to a tour of a museum, and measures the subjects on their ability to recall sequential progression, recognition of elements, and a cued recall (association) task, in which subjects listed the features that they remembered in response to cue words. In an experiment to attempt a detail comparison of learning from direct and simulated spatial knowledge acquisition, Goldin et al. (1981a) attempts to measure the landmark knowledge, procedural knowledge, and survey knowledge. To accomplish this they use location recognition tests for landmark knowledge, and they also tested the location sequencing task using sequence of actions performed at various locations that constitute the route specifications, serial order of the perceptual features encountered along the route, distance between locations experienced as sensations of motion, speed and time, and local angle information represented as bearing changed along the route. The study also measured estimate of route distance and orientation. Survey knowledge was tested using Euclidean distance tests and landmark placement task (Golding et al., 1981a). Experiments have been conducted by Golding et al. (1981b) to measure different types of experiences resulting in different types of spatial knowledge's (landscape, route and survey) in these experiments measurements were made on tasks of orientation, route distance, map drawing, and euclidean distance. Taking into consideration studies conducted by Thorndyke (1981), Craik (1968), Cohen (1980), Goldin et al. (1981a, 1981b), within this study Spatial knowledge is measured through efficiency based methods such as association tasks, judgmental tasks, distance perception tasks, recognition/memory recall tasks, preferences and accuracy based methods such as task completion duration, and error calculation.

SENSE OF BELONGING

Sense of belonging has been identified as one of the basic human needs and an important component to individuals, family, and community (Hill, 2006; Krause & Wulff, 2005; Vanderhorst & McLaren, 2005; Winter-Collins & McDaniel, 2000). Previous literature has reported the significance of sense of belonging for psychological, social, and physical well being (Hagerty & Patusky, 1995; Hagerty, Williams, & Oe, 2002) and deficits in sense of belonging have been linked to problems in social and psychological functioning (Hagerty, et al., 2002; Hill, 2006). The concept of sense of belonging can be found in many disciplines including social sciences, education, and psychology. However, this study concentrates on research within the academic field to relate with the design typology

and objective of the study. Hagerty and colleagues advanced the concept of sense of belonging by defining it as “the experience of personal involvement in a system or environment so that the persons feel themselves to be an integral part of that system or environment” (Hagerty, et al., 2002, p. 796). The closest and most focused definition for sense of belonging in educational studies was defined by Pintrich and Maehr (2004) as “the sense of psychological membership in the school or classroom, that is, the extent to which students feel personally accepted, respected, included, and supported by others in the school environment” (pg. 28). Sense of belonging deals greatly with human behavior and the interaction with the surrounding environment, which is in this study an academic environment.

Sense of belonging can be measured through several variables. The study of Furrer & Skinner (2003) explored the effects of a sense of belonging on academic motivation and performance by connecting the affiliation and affinity of individuals to family members, classmates, and friends. Maestas et al. (2007) considered a related operationalization by comprising membership and partnership with the college community as the variables for sense of belonging. Reilly & Fitzpatrick (2009) had a similar operationalization for the concept by measuring community activity participation, and family support. These variables could be grouped and addressed in fitting within the environment, valued involvement, respect and encouragement for participation, being part of a system, social support, social interactions, feeling the support, and affiliation and affinity between individuals.

Hagerty and Patusky (1995) developed a tool to measure sense of belonging that was adapted to a great extent. The concept was constructed on two dimensions, antecedent and psychological dimensions, measured by fitting within the environment and valued involvement. In a similar study in the educational field by Goodenew (1993), an instrument was created to measure the concept based on respect and encouragement for participation, involvement of the perceived responses of other members, and being part of the society. Hoffman et al. (2002) developed several measures of sense of belonging that includes students’ perceptions of academic and social support, social interactions, isolation, and comfort variables. A similar approach was observed in the study of Newhouse et al. (2007) where the concept was measured based on feeling the membership, comfort, and support in college. In an attempt to measure the overall effect of sense of belonging, Johnson et al. (2007) developed a simplified instrument to measure sense of belonging as a whole to indicate the level of sense of belonging. Taking in to account the studies conducted by The study of Furrer & Skinner (2003), Maestas et al. (2007), Reilly & Fitzpatrick (2009) Hagerty and Patusky (1995), Goodenew (1993), Hoffman et al. (2002), Newhouse et al. (2007), Johnson et al. (2007) we see that the measurements used in the literature to measure the concept counted extensively on self report instruments to measure the variables on an ordinal level using likert-type scales. The generally adopted instrument, the Sense of Belonging Instrument developed by Hagerty and Patusky (1995), is a 33-items self-report questionnaire in a 4-point likert scale that measures an individual’s sense of belonging. The scale consists of two important dimensions that are essential for an individual to experience the sense of belonging, antecedent and psychological dimensions. Their measurement was adopted by studies that follow based on its reliability and its flexibility to measure the concept in other domains.

METHOD

The aim of the study was to investigate the relationship between sense of belonging and spatial knowledge at an academic setting. In accordance with the primary hypothesis of the study that increased spatial knowledge of an environment provides heightened sense of belonging, the independent variable considered in the study was spatial knowledge and sense of belonging as the dependent variable. For the purpose of the paper, spatial knowledge was defined as the knowledge about the space which one occupies required to navigate through an environment while sense of belonging was defined as the experience of personal involvement in an environment so that the persons feel themselves to be an integral part of that environment, Spatial knowledge was constructed in three integral parts, landmarks knowledge, route knowledge, and survey, , and sense of belonging was constructed on the level of affinity a student feels toward the campus and peers To measure the college students’ level of sense of belonging to the University of Missouri, a questionnaire was devised. It was grounded on the sense of belonging operationalizations previously described and

comprised items typical for measuring sense of belonging. The instrument for sense of belonging was developed using the Hagerty's 27 items questionnaire, Goodenow's 18 items questionnaire and Hofman's 18 items questionnaire. The sense of belonging questionnaire presented questions which were designed to measure the subject's sense of belongingness under four levels. The first level was peer relationships: how a subject feels connected to his or her friends, if they feel that they belong to a certain social group or not. The second level was relationships with mentors: how a subject thinks that his or her mentors see him or her, if there is a close mentor-student relationship or not. The third level was belonging to the department of study, and the fourth level was the belonging to the whole university. Some items of Sense of Belonging in the developed instrument were reversed and re-coded after collecting the data to have all scales in a positive direction.

The spatial knowledge a questionnaire was grounded on the operationalizations previously described and comprised items typical for measuring spatial knowledge. The questionnaire was based on the studies conducted by Thorndyke & Golding (Golding et al. 1981; Thorndyke et al. 1981). The tool that was used in the study measured the three main aspects of spatial knowledge: landmark, route and survey knowledge.

The sense of belonging questionnaire contained 20 items measured on an eight-point likert scale, ranging from 1 (Strongly Disagree) to 8 (Strongly Agree). The spatial knowledge questionnaire contained 18 items, of which 13 items were measured on an eight-point likert scale, ranging from 1 (Strongly Disagree) to 8 (Strongly Agree) that measured the subject's general abilities of understanding spatial arrangements, and 5 items which were oriented towards the spatial understanding of the University of Missouri-Columbia.

The sample was selected on a voluntarily basis and consisted of 63 undergraduate students from the Department of Architectural Studies, University of Missouri-Columbia, 19 male and 44 female, within the age range of 18–32. One respondent with conflicting results was eliminated in the analysis to increase the reliability of the result. Extensive listings of the subjects' characteristics are displayed

Demographic Variables	Frequency	Percentage	Mean
Gender			
Male	19	30.64%	
Female	43	69.35%	
Race			
African American	7	11%	
Chinese	2	3.27%	
Korean	1	1.63%	
Vietnamese	1	1.63%	
White	49	80%	
Hispanic	1	1.63%	
Age			20.9193
Hometown			
Columbia, MO	5	8.06%	
Other cities, MO	53	85.48%	
Other states, US	3	4.83%	
Other countries	1	1.63%	
No. of years living in Missouri			3.27
Living location			
In campus	13	20.96%	
Off campus	49	79.03%	
Academic level			
Freshman	9	14.51%	
Sophomore	21	33.87%	
Junior	16	25.80%	
Senior	16	25.80%	
Had a guide tour			
Yes	40	64.51%	
No	22	35.48%	
Academic performance			
Excellent	23	37.70%	
Good	34	55.73%	
Neutral	3	4.91%	
Bad	1	1.63%	

Table 1: Sample demographics of this study (N=62)

Variable	n	M	SD	median	Range
Spatial Knowledge	18				
Landmarks		0.8	0.22	0.75	1-0.25
Route		4.2	0.98	4.28	6.1-2.07
Survey		36.46	9.22	36.86	55.25-1315
Sense of Belonging	20	6.53	0.94	6.5	7.8-3.09

Table 2: Descriptive statistics

	Spatial Knowledge									
	Landmark		Route Time		Route Distance		Route Direction		Survey	
	R ²	β	R ²	β	R ²	β	R ²	β	R ²	β
Sense of Belonging	0.01	0.31*	0.07	-0.27*	0.06	0.25*	0.13	0.37**	0.002	0.04

* $p < .05$, ** $p < .005$

Note: This table showcase the probability of spatial knowledge variables to predict sense of belonging. A significant value of a spatial knowledge variable determines its involvement to achieving higher level of sense of belonging

Table 3: Prediction of spatial knowledge on sense of belonging

in Table 1. All subjects volunteered to participate in the study and signed an informed consent form. An appointment was set with the investigator at the place of recruitment (classroom in Department of Architectural Studies) and the study was explained to potential participants. Those who wished to participate signed the consent form and were then asked to fill out a survey.

ANALYSIS

Regression test was used to determine the effects of the independent variables on the dependent variables. All analyses were performed by using procedures in JMP Version 8.0. The average age of students was 20 year and the majority of the sample (70%) was females. Half of the participants were majoring in interior design (50%), less than half in Architecture (40%), and the rest in other majors (10%). Table 2 provides the descriptive statistics for the variables Sense of belonging, Landmarks, Route, and Survey.

It was found that landmark knowledge predicted sense of belonging ($R^2 = .09$, $F(1,59) = 6.40$, $p < .01$), as did route. Route knowledge was tested with three factors, route time ($p = .02$), distance ($p = .049$), and direction ($p = .003$) estimation. Each of these three factors was highly significant, with R^2 between .06 and .13, while having a negative effect with route time. Survey knowledge failed to predict sense of belonging. A list of the regression analysis results is displayed in table 3. A one-way ANOVA test was also used to determine the relationship between sense of belonging and academic performance. There was a significant main effect for sense of belonging, $F(3,60) = 3.27$, $p < 0.05$, which suggests that participants with higher level of sense of belonging achieved higher academic performance.

DISCUSSION

In our analysis it was shown that that landmark knowledge predicted sense of belonging and route knowledge tested through the three factors, route time, distance, and direction estimation also predicted sense of belonging. Survey knowledge failed to predict sense of belonging

Sense of belonging is essentially related with familiarity to an environment. In fact familiarity contributes to a sense of belonging of the particular environment (Annison, J., 2000; Goodenow, 1993), and familiarity is considered one of the key psychological processes that link people with an environment together (Inalhan & Finch, 2004). Familiarity can be defined as the process which people develop detailed cognitive knowledge of their environments (Fullilove, 1996). It has been shown that familiarity effects wayfinding tasks in an environment (Hölscher, et al. 2006) and this can be considered the reason for the prediction. The more an environment is familiar to the user, the sense



Figure 1. Jesse hall and columns at the University of Missouri-Columbia

of belonging increases. Significant landmarks can symbolically represent that particular environment. For example in the case of the University of Missouri, Columbia, landmarks such as Jesse hall and the columns have become symbols of the university.

These reference points provide greater familiarity of an environment (Sorrows, M et al. 1999). The explanation for sense of belonging not predicting survey is less clear. The reason for this might have been due to the unequal distribution of female participation in the study. Gender differences in visual spatial skills (Geary, 2009) may affect the way female students perceive themselves, especially in the architecture department since architectural ability is dependent upon visual and spatial skills (Silverman, L.K., & Freed, J.N., 1991).

Since survey knowledge is specific to the individual and is mainly dependent upon his/her ability of conceiving cognitive maps of the environment, only route and landmark knowledge of the environment provides imageability. While the environment could be enhanced to provide more landmark and route knowledge which in turn will provide more familiarity and sense of belonging to the student, survey knowledge is more dependent upon the individual. In this study, significance was found in route time ($p = .02$), distance ($p = .049$), and direction ($p = .003$) estimation with sense of belonging. All the significance with the results suggests that our main hypothesis, that the increased spatial knowledge would lead to better sense of belonging towards that environment, was supported through the study.

There are several potential limitations to the study. The results of the study are only limited to the study's context specific to the location of the study at University of Missouri-Columbia. The sample is a main limitation to the study. Even though a significance between gender and sense of belonging was found, it is not a reliable one due to the unequal size of the sample that does not represent the population. Future research is needed to explore the effects of sense of belonging on additional components to spatial knowledge. The effects of sense of belonging on subjects other than students from the architectural department should be studied. Individual characteristics such as income, social status, and culture should be considered to have a better association on their perception. The questionnaire should be pretested and developed further to include more spatial components, such as adding extra landmarks recognition, to gather more solid data. Having a tour guide around the campus may affect the results of the study. Students who were guided and introduced to the campus

are supposedly more familiar with MU campus and its distinguished spatial characteristics. Therefore, treating this variable as a control variable is beneficial in future studies. Finally, the regression analysis revealed a negative relationship between landmark recognition and age. This may suggest that older students do not remember landmarks as much as younger students which in turns reflect in the accuracy of the data.

CONCLUSION

Increasing the imageability of an environment will make that environment more legible and more navigable (Lynch, 1960) and will increase the ability of spatial knowledge acquisition which will reduce the time it takes for an environment to become more familiar. Since familiarity contributes to the sense of belonging to a place, our hypotheses states that the increase in spatial knowledge acquisition would lead to the increase in sense of belonging to that place. The analysis presents some significant evidence which would propose a connection between these two variables. Increasing the sense of belonging to a place can yield valuable results especially to a school/university environment (Pintrich et al. 2003). Not only does sense of belonging foster better academic standing in students it also is linked with other sociological factors such as relationships with peers and respecting norms and values of a society, more over their feeling about themselves and self confidence. (Osterman, K., 2000 ; Furrer, C et al. 2003; Hurtado, S., & Carter, D. 1997). Identifying the relationship between spatial knowledge and sense of belonging relates to understanding the connection between university students and their environments. This knowledge will prove invaluable in providing the ideal academic environment by creating settings for students which are more imageable as well as navigable.

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Energy performance assessment of a naturally ventilated combined shaft-corridor DSF in an office building in Chicago

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ABSTRACT:

There is a great deal of interest in using double skin facade (DSF) strategies in new and retrofitted buildings, as they provide many possibilities for energy conservation, and at the same time create better thermal comfort. For hundreds of years, architects have tended to rely on intuitive guesses to design naturally ventilated buildings without detailed analyses. The lack of numerical airflow information that demonstrates the complexity and challenges in the domain of designing large naturally ventilated buildings is addressed in the literature reviews.

For these types of buildings it is important to have tools for analysis of design to evaluate a design's predicted performance in order to achieve successful natural ventilation concepts.

This study attempts to examine if the reliable simulation techniques verify the intuitive flow performance of double skin facades in a new configuration of natural ventilated building that results in reducing the energy demands yet provide both comfortable and healthy environments. The goal of this paper is to compare the base case of a typical office building in Chicago with two conventional DSF configuration and new (combined shaft-corridor) type.

CONFERENCE THEME: On Measurement

KEYWORDS: Energy performance, double skin facade, natural ventilation.

INTRODUCTION

With the emergence of energy-consumption reduction as a major national concern, the search for better approaches in improving both thermal comfort conditions and the energy efficiency of buildings is intensifying. Currently, low-energy building design features include lighting and controls, ventilation systems, and an improved building envelope. Lighting energy can be reduced through the use of natural daylighting, high efficiency fixtures and controls, such as occupancy sensors that turn lights off when there is no movement, and photosensors that reduce light output as needed to maintain a minimum level. These technologies, combined with architectural details like light shelves, high windows, external shading, and double-skin facades, increase natural daylight while reducing energy consumption associated with artificial light. Energy-consuming systems required for providing fresh air to meet indoor air quality requirements can be reduced or eliminated with the use of passive or hybrid technologies. Hybrid ventilation, or the use of natural and mechanical systems to cool and ventilate buildings, offers opportunities to take advantage of external conditions, but require a backup system to maintain the indoor environment when these conditions are not adequate. Additionally, the building facade plays an important role in achieving energy conservation. Due to technological advances, transparency and the use of glass has become an attractive envelope option in architectural design. Building glass facades can provide outdoor views and an excellent level of natural light as well as the potential for natural ventilation. However, with the use of glass, heat loss during the winter and solar gain during the summer will increase energy loads. In central Europe, which has moderate-to-cold climates, new concepts were tested that used outdoor conditions in creating climatic-responsive buildings (Givoni, 1998; Szokolay, 1980; Wigginton, 1996). Advanced facade technologies were developed for the high-end office building sector, in particular (Wigginton, 2002), and designers tried to integrate more building services into the facade system. By integrating the use of thermal mass, building-envelope systems can help temper the internal environment, and reduce the amount of supplementary heating or cooling needed to maintain occupant comfort.

This study provides a detailed description of the reference building model as designed and used

for energy analysis in EnergyPlus- DesignBuilder. The building is modelled to assess the energy performance of incorporating of three types of DSFs in comparison with the reference building. A naturally ventilated combined shaft-corridor DSF and two typical corridor and shafts are studied and compared with a single skin facade. The building is assumed to be in Chicago for simulation and weather-data purposes.

To study the facade design's impact on the space heating and cooling, a breakdown of energy components and overall energy consumption of a typical office building is presented.

First, the components of the reference building will be described. The next section discusses the influence of different types of DSFs on space heating and cooling in comparison with the base case office building. Finally, the results are compared with a traditional facade and with each other in terms of energy performance and thermal condition.

In this study, the energy performance of a high-rise office building equipped with conventional insulated glazing will be calculated by EnergyPlus and compared to a new DSF configuration. The DSF solution is innovative because it combines two common typologies: shaft and corridor type. The results proved that the new configuration had a major impact on enhancing natural ventilation and as a result, a reduction in energy usage.

I. DOUBLE SKIN FAÇADE

The concept of a DSF is not new and dates back to many years ago in central Europe when houses utilized box-type windows to increase thermal insulation (Oesterle, 2000). The DSF is an architectural phenomenon driven by the aesthetic desire for an all-glass facade and the practical desire to have natural ventilation for improved indoor air quality. Until recently the use of DSFs had become more popular in many European high-rise buildings.

A number of studies, research, and simulation programs have been done on incorporating natural ventilation in buildings and DSFs in thermal performance. Most have been carried out for solar chimneys—one way to increment natural ventilation and to improve indoor air quality—and Trombe walls prior to DSFs. Most designers found out that natural ventilation is possible in summer, even in multistory buildings (Wong, 2006). The potential of using a DSF for natural building ventilation in climates other than Europe has not, however, been fully studied.

In this study, wind-driven ventilation improved with stack effect in the novel DSF configuration and will be tested to see if it can maintain adequate comfort during summer and spring. The first step would be to study the ambience that will be used as CFD boundary conditions. Initial studies of the macroclimate were carried out through Ecotect, which allowed for efficient visualization of the local climatic conditions.

I.1. ENERGY USE IN OFFICE BUILDING

In general, energy consumption in buildings is determined by function, climate, building components, construction, control, and settings. The climate and the ambience are considered as-boundary conditions in energy simulation. Building function also has an important impact on energy use. As shown in Chapter One, significant amounts of energy (50 percent) go into the buildings and 23 percent of that goes into the office buildings. High occupancy and amounts of equipment increase the energy consumption as compared with residential buildings. Building components and construction both provide great potential for improvement of energy demand in such areas as adequate thermal insulation, a key component of energy consumption. In office buildings, a careful choice of windows and shading devices should help to avoid additional solar gains. Incorporating efficient HVAC equipment and heat recovery techniques may also reduce the energy use. Designing a high-performance facade system will make a tremendous impact in minimizing energy consumption and optimizing the thermal condition. To illustrate different energy components in offices, Figure 1 presents a breakdown of a typical Chicago office building. The results of this benchmark are presented in $\text{KW}/\text{m}^2 \text{ yr}$ and based on a survey of a large number of occupied office buildings. Typical patterns are representative for the median energy use of 2003 office buildings.

Energy End-Use Intensities for Office Buildings in Chicago

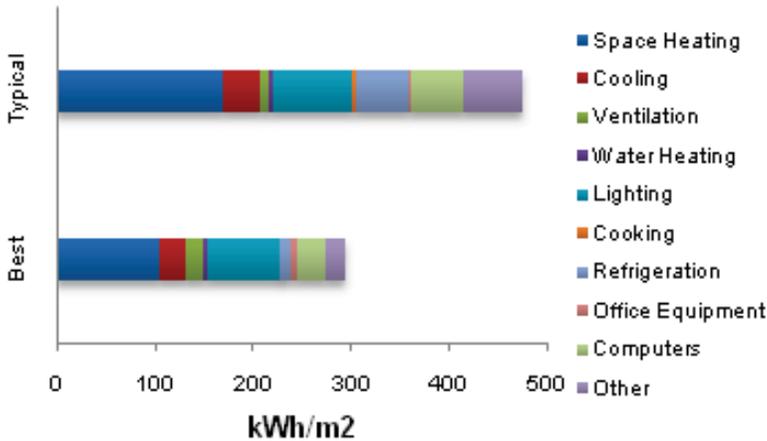


Figure 1: Energy components of typical office buildings (US Department of Energy, 2003)

2-METHODOLOGY

2.1. BASE CASE

The description concerns the real (designed) building, and the simulated model created for the energy and indoor-climate simulations.

The baseline facade configuration was a traditional, double glazed, low-E single skin facade.

Initially, the reference building was a 28-story building. It is a rectangular shape with an open plan. In terms of geometry and installations, the floors are completely identical. However, floors 1-27 are connected (floor, ceiling) with other internal building zones, while the roof on the 28th floor is connected to the outside, and the ground floor is the ground (i.e., no basement).

The height of the building is 98m, with a length of 78m, and a width of 32m. Room height is 3.5 m with a suspended ceiling. For this study, however, only part of the plan will be modelled both in energy simulation and airflow modelling analysis. It was assumed that the building divided into four blocks of 7-story high shaft modules. To simplify, the module to be studied is a rectangle 28 m by 8.5 m. The module area is 229.5 m² and includes 7 stories, making a total of 1,607m². The window area (including the frames) comprises 100 percent of the south facade. The interior design and the work places were not in the scope of the study. The four alternatives based on external skin types were compared in terms of energy use and the quality of thermal condition

2.2. INPUT

First, the site needed to be chosen as it defines the building's geographical location and weather data. Then the activity template, selected: open office space. The occupancy schedules and other data, such as metabolic rates and levels of equipment use, were set based on the office space requirements.

The occupants' schedules, activity levels, clothing and room use are tabulated in Table 1.

Zone Identification

To simplify the simulation, only one zone per story was identified. The office building faces south with 100 percent glazing.

Schedule for offices	08:00 -12:00, 13:00 – 17:00
Winter schedule	50% working during the Christmas vacations, otherwise 100% weekends closed
Summer schedule	75% working during July otherwise 100%, weekends closed
Activity level	Office Activity : 1 met = 108 W / occupant (1 met corresponds to 58.2 W / m ² body surface) Task: sitting, reading
Clothing	For winter conditions: 1 clo For summer conditions: 0.6 clo

Table 1: Occupants schedule and activity level

Zone properties description

The two main components of the energy simulation model are the building fabric and elements (walls, floors, ceilings, occupants, and equipment) and the plant components (HVAC equipment, and other environmental control systems). Ventilation, lighting and equipment, type of HVAC system, use of natural ventilation and daylighting should all be set in describing zone properties. For all of these values, office-building defaults were used, except for the HVAC system, which had a VAV system with terminal reheat that had been chosen for the base case. However, the base case was simulated with no natural ventilation. . The HVAC systems for all the cases are similar.

Then specific properties of each zone in terms of the wall properties (type, R-value, exposure, and construction), shading, window properties (type, glazing area, size and layout) needed to be set. The description of building's construction is shown in Table 2.

Building construction	Material type(from outside to inside)	Thick-ness (m)	Density (kg/m ⁻³)	U-value (W m ⁻² K ⁻¹)
External wall	Exposed concrete	0.10	1500	0.35
	Polystyrene	0.08	16	
	Concrete block	0.10	1000	
	Gypsum plastering	0.013	758	
Internal wall	Gypsum Plaster	0.025	970	1.9232
	Airgap 10mm	0.10	1.2	
	Gypsum Plaster	0.025	1090	
Floor	Cast concrete	0.10	2300	4.7
Ground floor	UF Foam	0.087	1200	0.35
	Cast concrete	0.10	2300	
	Creed	0.07	900	
	Wooden Flooring	0.03	1000	
Roof	Asphalt	0.01	930	0.25
	MW Glass wool	0.145	16	
	Airgap 25mm	0.20	2.5	
	Plasterboard	0.013	720	

Table 2: Description of building construction

The glass area in the base case is 100 percent in the south facade and double-pane low-E insulation was chosen for the glazing type. The thermal properties of materials were initially calculated by EnergyPlus- DesignBuilder. It should be noted that thermal losses due to thermal bridges were not included in these calculations. In order to be accurate, practical values should be used instead of theoretical values. The property of the reference window is as follows:

Window properties	Description	Aluminum window
	U value (W/m^2K)	4.719
Glazing properties	Description	DbI LoE($\epsilon=0.1$) Clr 6mm/13Air
	U value(W/m^2K)	2.44
	SHG	0.643
Frame properties	Description	Aluminum
	Thickness	0.02
	Surface resistance(m^2K/W)	0.040
Shading device	Description	Blinds with high reflectivity slats
	Control	Scheduled and positioned inside

Table 3: Properties of window on south façade

Other settings

Control points for the indoor environment were set at 22C minimum for winter and 24.5C for summer. The infiltration rate assumed for the reference building was 0.5 ACH (air changes per hour). There were 300 occupants in the building. The lighting was assumed to be florescent with a power of 10 W/m² 200lux and the annual equipment energy use for the open plan was 57 kWh/m². Another parameter was a control set for artificial lights, assuming that they are switched on according to occupant schedules.

2.2. OUTPUT: SIMULATION RESULTS FOR THE REFERENCE BUILDING

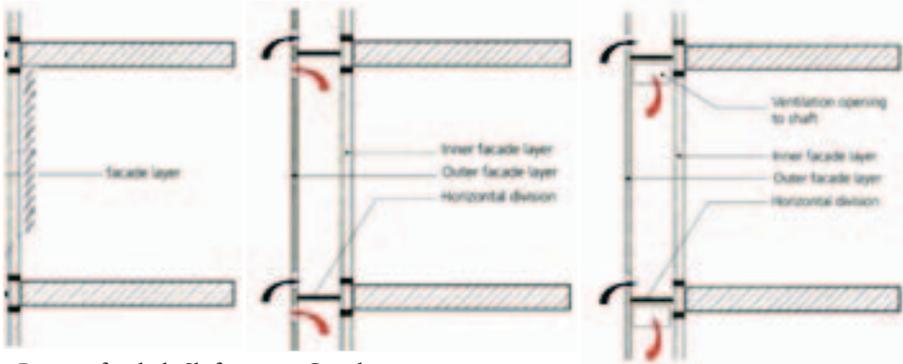
After the appropriate input to best define the typical office building was entered, the base case was simulated for the year's annual performance. EnergyPlus generates a detailed report of the heating/cooling energies, peak and annual cooling/heating loads, costs, and annual breakdown of energy consumption.

For this paper, only the most relevant output graphs were analyzed. The number of heating degree days far exceeded the number of cooling degree days and clearly showed the heating-season dominance. It was apparent that due to the cold conditions, the most significant loads and maximum energy use was for heating. In terms of breaking down annual energy consumption, the largest components were space heating, cooling, and lighting. A building cost analysis was omitted, as the major research objective was to study facades' thermal effects. The key point of adding a naturally ventilated DSF was to take some of the grid's cooling loads out. Therefore, the major focus of the analysis was on the following three output graphs:

- a) Annual Cooling and Heating Loads
- b) Breakdown of Energy Consumption

2.3. DESCRIPTION OF DOUBLE SKIN FACADE ALTERNATIVES

In this section, the energy performance of 7-story DSFs were studied and compared to the 7-story section of the reference building. The energy demands of the following facades were studied:



a: Base case facade b: Shaft type c: Corridor type

Figure 2: Diagram of the simulated double skin facades

- A seven-story naturally ventilated cavity shaft type
- A seven-story sealed outer skin-corridor type comprised of a single pane of clear glazing, wherein the facade acts as an external air curtain
- A seven-story naturally ventilated new DSF configuration combination of corridor and shaft type.

Two DSF construction types were assumed: a corridor type and a shaft type. In both cases, the cavity depth was assumed to be 1.5m and the shaft height was assumed to be 7 stories (3.5m height). The main difference of the alternative facades is that a double skin has been added to the building; with the internal skin the same as the reference building and the external skin as a single pane window (6mm). The shadings were located inside the cavity. In both DSF types, the building was mechanically ventilated, yet the cavity was naturally ventilated. The shading devices were considered to be white with a slat angle of 45°. Figure 2 shows these three alternatives for energy simulation.

The base case consists of a well insulating glazing with a U-value of 2.44 W/m² K and a solar transmittance of 0.634. The window is equipped with roller blind as shown in the Figure 2a. If we added a clear glass pane (6mm) in front of the base case with divisions along each story that allowed the exterior air to enter, the cavity a double skin facade corridor type is created (Figure 2-b). In the case of a shaft type, single glass was added to the exterior a small distance from the insulated internal glazing, while the extracted air goes to a shaft that goes through multiple stories and takes the exhaust air outside (Figure 2-c). The office was equipped with a mechanically ventilated system in case of variable weather condition and the natural airflow was not enough to provide cooling.

Almost all the literature studies noted advantages regarding the reduction of heating/cooling losses over traditional single facade systems. The lower radiant temperature increased building's thermal comfort. Also, during the winter, the cavity can act as a buffer zone and capture incident solar energy, which further improves the energy efficiency.

COMBINED SHAFT-CORRIDOR DSF

This study looks beyond typical shaft and corridor DSF solutions and provide a new type shaft-Corridor configuration. The combined shaft-corridor DSF configuration takes advantage of strategies such as ventilation driven by different combinations of wind and external stack. The most distinguishing visual feature of this configuration is it can pronounce a module by projecting or taking it back on the facade as presented in Figure 3. This configuration combined both shaft box and corridor types on the building's facade while trying to avoid their disadvantages. The cooling stacks allow for further ventilation on hot, stagnant, summer days so the building always remains within reasonable temperature levels, like that of an air-conditioned building.

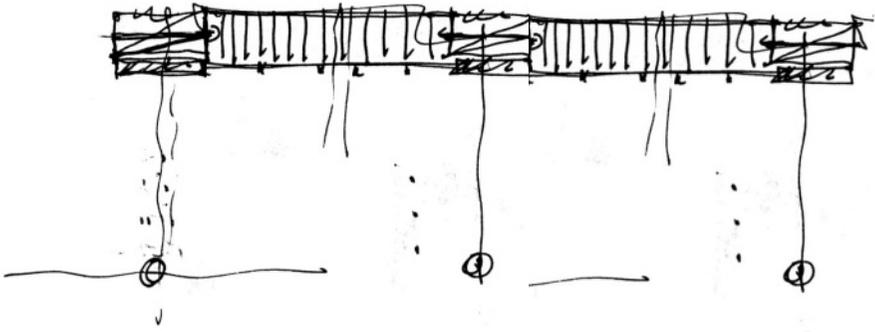


Figure 3: Sketch plan of the new configuration

One of the disadvantages of a shaft-type window is that the narrow width makes it difficult to clean and maintain. A corridor type can simply act as an internal or external air curtain. As a result, natural wind cannot be introduced to the interior space; if we open the internal screen the air inlet and exhaust air will mix. With the combined shaft-corridor DSF we tried to avoid the disadvantages mentioned above. To avoid air mixing, the inlet and exhausted air are separated through a channel. Exhausted office air will go directly into the transparent channel, which is connected to the shaft. In addition, the shaft width is increased up to 1.5m, the same as the corridor depth. Ventilation effectiveness is driven by thermal buoyancy, or stack effect, which is determined by the inlet air temperature, the height between inlet and outlet openings, and size of these openings.

Figure 4 shows how air flows through the chimney and provides ventilation inside each office module. The air gap inlet draws in fresh air at a low level and directs it into the room. The air is exhausted through the outlet at the high-level gap of the inner pane. The multi-story chimneys suck the exhausted air through a bypass opening at the top of the corridor facade. The vertical height of the glass chimney creates a stronger uplift force due to the increased stack effect.

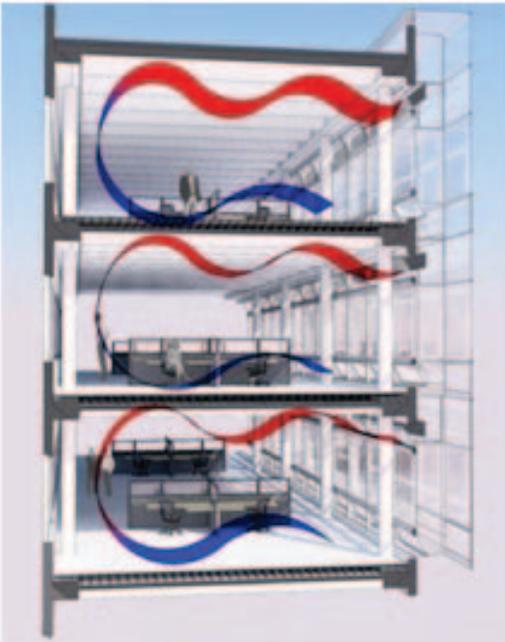


Figure 4: The combined shaft-corridor DSF configuration and show air flows within the building

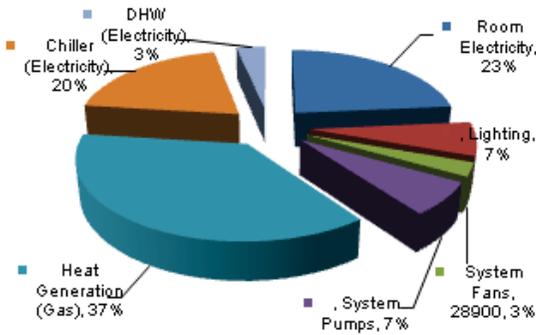


Figure 5: Energy breakdown in the combined shaft-corridor DSF configuration

3-RESLUTS: ENERGY USE SIMULATION RESULTS

An annual energy simulation on an hourly basis under Chicago climatic conditions was performed for different DSF alternatives. All inputs were the same as the reference building, with the same surface area. In the case of the corridor facade, the width of the corridor was 1.5m and the width of the shaft-type facade was 0.3m that passed through 7 stories. The energy performances of the different DSFs will be discussed in detail in this section.

The annual cooling and heating energy consumption of the combined shaft-corridor DSF is presented in Figure 5. When heating and cooling loads were compared, it is apparent that heating is the largest component of energy consumption. The heating season period is longer than the cooling season in Chicago.

The net annual gas consumption was reduced by 18 percent through the shaft, 16 percent through the corridor type, and 35 percent in the new type. As shown in Figure 6, the heating energy (gas consumption) was reduced in comparison with the two other typologies; however, in terms of cooling demand, electricity consumption decreased by five percent in the shaft type and nine percent in the corridor type. Total electricity was reduced by 15 percent in the combined shaft-corridor DSF. Cooling and heating demands will be discussed in detail for each month in the following section.

It should be emphasized that the results represent the space heating and cooling energy demands. Cooling efficiency differs from heating. The cooling demand is reduced each month in comparison with the base case, except for the month of July, when it is lower than the shaft and corridor types. However, the total annual cooling load was reduced by adding the DSF, as the exterior shading devices decreased the heating solar gain, and made it easier to lose the indirect solar gain. The results, consequences of the different climate, contradict Saalen's (2002) findings. They also indicate that the combined shaft-corridor DSF increased the natural ventilation even in hot summer months and would be a good option for the building.

Annual Energy Demand

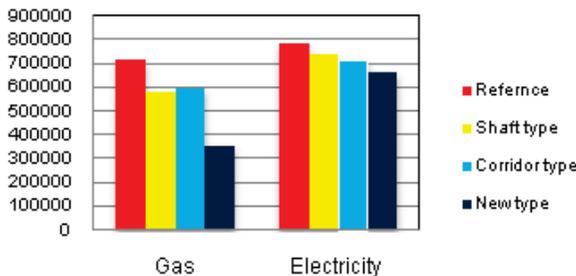


Figure 6: Annual gas and electricity demands

Cooling Energy Demand

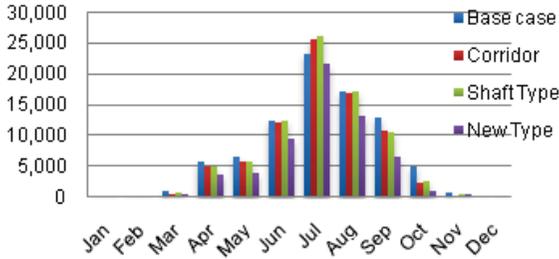


Figure 7: Annual net cooling demand for each month

The Figure 7 shows the cooling demand of each month for the four different alternatives. The total energy use for cooling has been reduced by 28 percent in the combined shaft-corridor DSF and by almost five and seven percent in the shaft and corridor types, respectively. Based on the energy simulation in Belgium by Saelens the south-oriented DSF requires 32 percent more for cooling energy than the traditional facade (Saelens, 2002), while the combined shaft-corridor DSF reduces cooling energy by 28 percent. Because of the extra pane, the DSF has a lower direct solar gain, and the shading devices situated outside while in the base case the blinds located inside which doesn't reduce the solar heat gain. In addition, with the combined shaft-corridor DSF we can take advantage of both wind and natural convection that has occurred in the stack, which improves the air velocity in eliminating the hot stuffy air from the building.

The total cooling energy is reduced by almost 28 percent, although this trend is not the same for all the types in each month, as shown in the Figure 8. The shaft and corridor types almost save the same amount, however, the total annual reduction in the corridor type is seven percent and five percent in the shaft type from the base case.

HEATING DEMAND

The energy use for heating in the combined shaft-corridor DSF configuration is several times lower than the base case demands and other DSF alternatives. In general, the results seem to be remarkably different than the cooling savings and can be explained by the following reasons: during the heating season the system would be closed thus no air is moving in the cavity. The cavity then heats up and increases the temperature of the inner pane and thereby reducing conductive, convective, and radiant losses. In addition, the whole system increases the R-value of the enclosure by providing a buffer zone in front of the inner pane. The difference between the maximum and minimum heating load is more pronounced than it was for the cooling demand. It can be concluded that in the Chicago climate, the extra pane can lower the heating load by 22 percent.

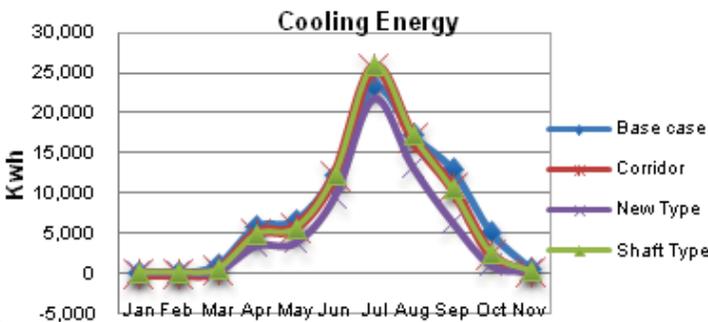


Figure 8: Cooling energy demand for four different enclosures

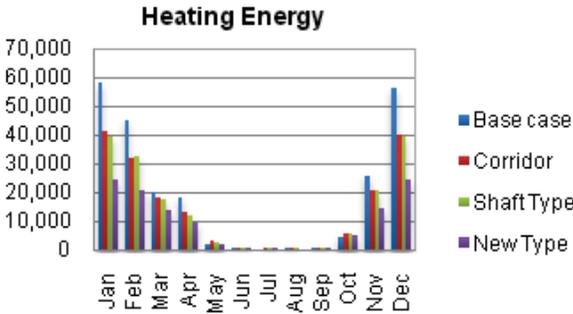


Figure 9: Heating energy demand for each month

SIMULATION RESULTS FOR THE BUILDING

In this section, the energy-use difference for heating, cooling, and lighting is compared with the three alternative facades and the base case. The energy use for heating in the reference building is 34.7KWh/m² (25%) higher than the shaft and corridor types and 72 KWh/m² (50%) higher than the combined shaft-corridor type, respectively. As expected, in all cases the energy use for heating and cooling was higher than the reference building. However, as shown in Figure 10, lighting increased in the shaft and in the combined shaft-corridor DSF in comparison with the base case by one percent. It can be concluded that 100 percent glazing provides more daylight than the combined shaft-corridor DSF and shaft types, which makes sense.

The heating energy intensity was reduced by 50 percent in the new type and 28 percent in cooling energy intensity. In total, compared with the base case, the corridor type reduced energy by 12 percent, shaft by 11 percent and the combined shaft-corridor DSF by 29 percent.

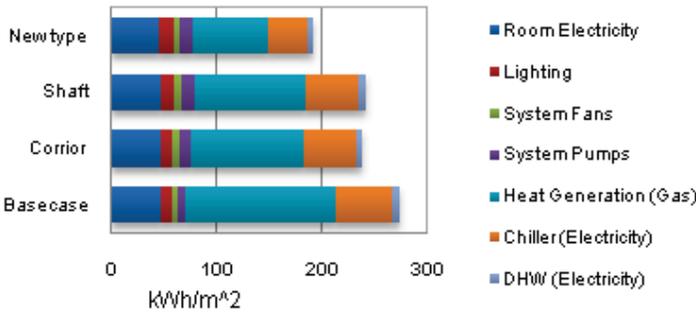


Figure 10: Impact of facade types on energy use

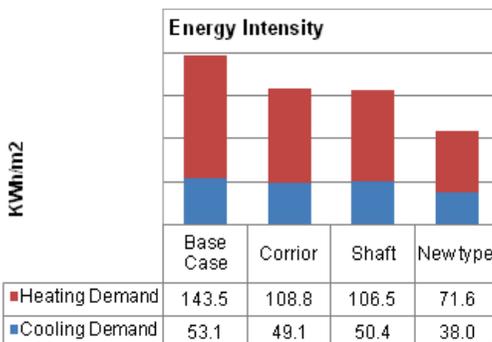


Figure 11: Energy intensity of alternatives

Case	Energy Intensity KWh/m ² yr	Percent Savings (%)
Base	274.1	
Corridor	239.3	12
Shaft	241.7	11
combined shaft-corridor	192.7	30

Table 4: Energy intensity of 4 cases and the percentage of savings

ENERGY COMPARISON

The annual energy usage per square feet area of the new DSF type, which is a combination of two typical DSF types, has been tabulated and illustrated below. The energy intensity of the new type compared with shaft and corridor types as well as an average office building in Chicago as a base case model is also shown.

It was discovered that the heating energy intensity was reduced by 50 percent in the new type from the base case, and there was a 28 percent reduction in cooling energy intensity.

In total, compared with the base case (an average office building in Chicago), the corridor type reduced energy usage by 12 percent, shaft by 11 percent and the new type by 29 percent, respectively.

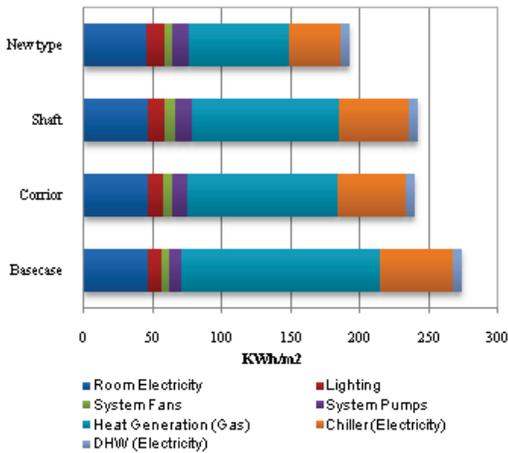


Figure 12. Simulation results for different alternatives.

CASE	Energy Intensity KBtu/SF yr	Heating Consumption Kbtu/SF yr	Heating Reduction %	Cooling Consumption Kbtu/SF yr	Cooling Reduction %
Reference building	86.87977	45.5		16.8	
Corridor type	75.86	34.5	24	15.6	7
Shaft type	76.6095	33.8	25	16.0	5
New Configuration	61.07612	22.7	50	12.0	28

Table 5: Energy usage comparisons for different alternatives

4-CONCLUSION

While there is a great deal of interest in transparent building in current architecture, larger areas of glazing area results in high building heating and cooling loads, and high levels of energy consumption. The advent of the double skin facade is a response to these problems.

In order to reduce energy use and improve indoor thermal environment, a new DSF configuration was introduced. The new DSF is a system consisting of corridor and shaft types. In this new type, chimneys are placed in such a way that air can flow through the intermediate cavity with no mixing of inlet and exhaust air. In principle, the main purpose of the DSFs (as to energy use and thermal comfort) is to allow useful solar gains into the building and to introduce natural ventilation during the shoulder season.

The energy savings achieved for this new type has been investigated to evaluate energy performance of incorporating this type in comparison with typical DSF types in high-rise office buildings in Chicago. The findings would be of utmost important in determining whether a DSF is a real possibility in incorporating natural ventilation and reducing energy usage in both heating and cooling in Chicago climate. The research found that in total, compared with the base case (an average office building in Chicago), the corridor type reduced energy usage by 12 percent, shaft by 11 percent and the new type by 29 percent, respectively.

In conclusion this new type of DSF has advantages over the typical curtain wall system in reducing the cooling load by allowing wind to be introduced as the driving force in combination with the stack effect to enhance natural ventilation.

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Sustainability vs. Performance

Impact of reducing thickness of brick in veneer walls

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ABSTRACT:

The objective of this study was to investigate the effect of reducing the thickness of clay brick veneer on its water penetration performance and associated environmental impact. Thinner brick would mean reduction in material which would in turn impact transportation and installation. To examine the performance of thinner bricks, two brick samples were used for comparison: brick with standard 90mm width and brick with reduced width of 75mm. This change in width represents a 17% volumetric reduction in material used. Could this reduction in material be obtained without impacting the performance of the brick veneer?

The study at Ryerson compared the standard veneer brick with a thinner brick veneer by conducting water penetration tests on six wall specimens- three of each brick veneer. The initial results showed that thinner veneer allowed less water to penetrate through than the thicker one. Further tests were done specifically looking into the absorption characteristics of both brick samples. The water penetration tests were repeated to simulate different wind-driven rain conditions. Comparing the results from all the tests, it was observed that the thinner walls perform better. The lower water penetration of the thinner walls seemed directly linked to the fact that they have an IRA that is close to three times that of the standard bricks. This may result in better bond between mortar and brick which could result in less water leaking through the joints.

The investigation into the environmental impact of thinner brick veneer indicates that significant savings in energy, green house gases and other environmental aspects could be achieved if the thinner veneer is adopted Canada-wide.

This paper points to further studies that would be required to see the effect thickness has on brick veneer performance.

CONFERENCE THEME: Considering Research: Reflecting upon current themes in Architectural Research

KEYWORDS: clay brick veneer, water penetration, thickness, embodied energy, environmental impact

INTRODUCTION

Brick is one of the most commonly used cladding materials in single family houses in many regions of Canada. In addition to providing warmth and character to the building, brick also in modern buildings is used to act as a rain screen in the building envelope system. A rain screen may be defined as the outer leaf or cladding that “screens” the rain which works together with an inner leaf which acts as the drainage plane. The drainage plane and outer cladding are separated by an air space which helps with removal of water from behind the cladding and promotes faster drying of the wall (Brook 2005). Essentially the brick acts as a cladding element and does not support the primary structural loads.

For years bricks with a standard width of 90mm have been used in veneer construction. Can the thickness of the brick used as a veneer be reduced without affecting its performance? If the thickness is reduced how much can it contribute towards improving sustainability of the brick wall? The study focused on the brick veneer component of the building envelope as shown in figure1. Material reduction is an effective means of addressing sustainability as it directly impacts non-renewable resource consumption and the quality of environment that is impacted by production of materials. Reducing the width however begins to affect the effectiveness of the veneer to perform its function as a separator.

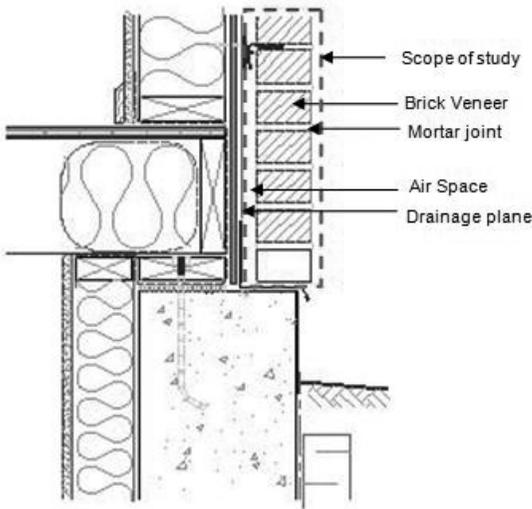


Figure 1: Typical Section- Brick Veneer wall at foundation showing scope of study. Source: (Wood frame envelopes 2001)

Regardless of the extent of impact on the sustainability of the wall, reduced thickness of brick is worth considering from the point of view of economics. This paper examines the two issues related to sustainability and performance as a veneer. There are many aspects to sustainability and performance. This paper focuses on sustainability from the point of view of environmental issues expressed through embodied energy and the performance from the point of view of the walls effectiveness as a rain screen. It identifies other issues related to sustainability and performance that are important and which may be considered in future studies.

I. STUDY APPROACH

The environmental impact of the reduction of brick width was calculated based on a simple model that relied on determining the reduction in mass and volume of the brick for a prototypical single family home. The reduction in mass and volume were determined and applied to standard values for the environmental impact of bricks available from literature. The environmental impact of such practices will vary widely from region to region depending on such issues such as local availability of material, transportation requirements, and sensitivity to impact on the natural environment. While the method used in this paper applies to buildings in Ontario, similar approach can be used to produce local results.

The performance of the brick veneer was measured by conducting tests on mock-up walls in the laboratory.

Water penetration tests and absorption tests according to ASTM standards and ISO protocols were conducted on two sample bricks described in Table 1 below-

Brick Sample	Size	Dimensions (mm)
Series"0"/ Standard	Cortes Max (3:1)	257 X 90X 79
Series"1"/ Thin	Premier Plus	257 X 75 X 79

Table 1: Details of brick samples

2. ENVIRONMENTAL IMPACT OF REDUCED BRICK THICKNESS IN A VENEER WALL

Reducing brick veneer thickness directly reduces the amount of material required for the same amount of surface coverage for its use in the building cladding. For a given area of finished wall, there are many benefits including:

Lesser use of resources

Lesser waste at the end of life cycle

Reduction in energy used to produce and transport the material

Higher efficiency in terms of installation due to better ergonomic considerations

Reduction in dead loads from the cladding

This paper focuses on the environmental impacts based on the life cycle assessment. The following sections examine the environmental impact from brick production.

2.1. REDUCTION OF MATERIAL

By reducing the thickness of a standard brick veneer from 90mm to 75mm, we reduce the total volume of the brick by approximately 17% i.e. a reduction of approximately 310cm³ per brick. To put this into perspective, this paper uses an example of a typical two storey detached house in Ontario with the following characteristics:

No. of storeys: 2

Height: 5 meters

Floor Area on two storeys: 250 m²

Total Area of opaque portion of cladding : 260 m²

The number of bricks required to clad 260 m² would be approximately 10,800 brick units. If instead of the standard bricks the thinner bricks were used then, the amount of material saved would be approximately 3.3 m³. The reduced volume of bricks works out to approximately 1,800 bricks.

This is a significant amount considering the fact that in 2008 and 2009 (a year which was considered a low point in the housing market), there were approximately 200,000 and 150,000 new homes being built all across Canada respectively (CMHC 2010). This means saving of 360 (270 in 2009) millions bricks in 2008 or brick cladding for additional 33,333 (25,000) new homes.

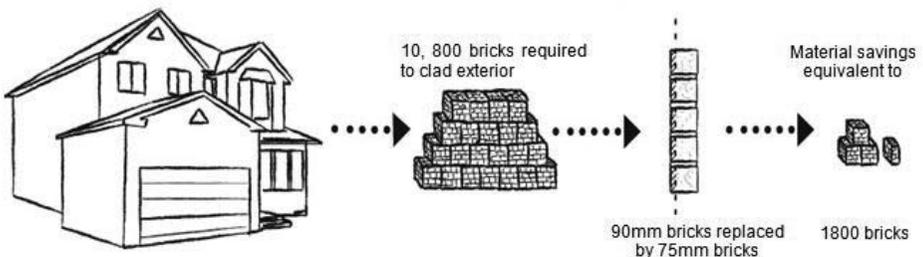


Figure 2: Amount of bricks saved in a typical single family detached house in Ontario, Canada.

2.2. REDUCTION CO2 EMISSIONS AND ENVIRONMENTAL IMPACT

One small step such as reducing the material used in brick production would also lead to saving large amounts of energy and reduce the amount of carbon dioxide emissions. The ATHENA institute has published a life cycle analysis report on brick and mortar products. The report considers different aspects from production to transportation and the impact each of these processes have on the environment in terms of energy consumption, emissions etc. (Venta 1998). The reduction in material consumption from previous example of a typical single detached house was analysed in terms of these aspects and the findings are discussed.

A sound indicator of a product's impacts on the environment is its embodied energy which is defined as the total energy consumed for various processes (extraction of raw material, production, transportation etc.) involved in creating a finished product. The embodied energy for clay bricks is 6.6 GJ/m³ of finished brick. The total embodied energy of the bricks on the house is approximately 132GJ. Using thinner bricks would reduce this to 110GJ that is 22GJ of energy saved for a single detached house alone. If thinner bricks were used on all the new housing that was built in 2008, the total amount of energy saved would equal to 4488000 GJ of energy. This energy is sufficient to heat approximately 40- 50 single detached houses for a year (Natural Resource Canada 2010). Similarly other aspects that impact energy and environment that would be effected by reducing brick veneer thickness is shown in Table 2.

Environmental Aspects	Standard Brick	Thinner Brick	Reduction of
Non renewable energy consumption in GJ	57.2 GJ	48.1 GJ	9.1 GJ
Green house effect / CO2 emissions equivalent in kg	6582 kg	5530 kg	1052 kg
Acidification/ SOx equivalent in kg	7.4 kg	6.2 kg	1.2 kg
Nitrification equivalent in/ Ammonium in g	17.28 g	14.5 g	2.8 g

Table 2: Comparison of standard vs. thinner brick veneer in terms of energy consumption and emissions

It is clear from the above discussed example that a significant amount of energy can be saved by adopting thinner brick veneer. Several atmospheric emissions and effluents which cause environmental issues such as ozone depletion, acid rain, nitrification etc. can also be reduced. It should be noted that potential reduction in mortar use for thinner veneer wall was not included in the above estimates.

There are two ways in which the brick veneer may be considered to contribute to the thermal properties of the exterior wall. One is through the thermal resistance to conductive heat flow typically measured in terms of R-value. In a rain screen pressure equalized type of wall system assumed in this paper, the brick is simply a veneer between the pressure equalized cavity and the exterior. In this type of application the brick veneer's R-value is not effective and does not contribute much towards the total R-value of the building envelope. Therefore reducing the thickness of the brick would not have any significant impact on the heating/ cooling loads of a building from a conductive heat loss or gain point of view. The second way in which the brick affects the thermal properties of a wall is through its thermal mass. Some of the studies mentioned before have shown that the temperature of the cavity adjacent to the brick is affected by the heat storage due to the thermal mass of the brick. Reducing the thickness will reduce the thermal mass and therefore it may have a slight impact on the overall heating/cooling loads of a building.

From an overall perspective, considering all environmental factors such reducing need for natural material, emissions etc. this increase in heating/ cooling loads would be insignificant and it would still be worthwhile to reduce thickness of brick.

3. FACTORS EFFECTING WATER PENETRATION IN BRICK VENEER

Several studies on brick veneer were reviewed particularly focusing on factors that affect the performance in terms of durability, water penetration etc. It was important to understand these factors and their effects to analyse the results from the water penetration tests and assess why one wall performed better than the other. One of the most important criteria that decide the performance of a brick veneer wall is the amount of water that penetrates through the wall or gets absorbed by the wall. The following sections evaluate the effect of variables such as mortar joints, void area, initial rate of absorption etc. on water penetration.

3.1. INITIAL RATE OF ABSORPTION

To reduce water penetration in a wall, it is important to realise its flow pattern through a given surface. Water flows through the path of least resistance and so within a brick wall it flows through area of contact between brick and mortar (Whitlock 2003). This was proved in a study done by Thomas Hines when he claimed that neither the brick unit nor the mortar itself allows any significant leakage through their respective materials (Hines 1991). Most of the water migrates through minute, mostly invisible to the naked eye cracks that develop over a period of time. These cracks might form due to various reasons but a major deciding factor is the Initial Rate of Absorption (IRA) of the brick. It is the IRA which is directly responsible for the bond formed between the mortar and the brick when the wall is laid and the subsequent chemical reactions that occur. Higher the IRA, better the bond between brick and mortar.

3.2. MORTAR JOINTS

Mortar joints play a crucial role in a brick walls resistance to water presentation. Width of a joint affects leakage; thinner mortar joints perform better than wider joints. It is critical for the vertical joints to be completely filled even more than the horizontal joints as these joints do not undergo natural compression from the weight of the bricks above. Hence it is through these joints that most of the leakages occur. Width of the joint is another factor which affects leakages (Roller 1994).

3.3. WORKMANSHIP

While laying bricks, it is important that certain techniques are followed for proper bonding and minimising cracks. Good workmanship ensures a wall that is durable and works as a better rain screen. Bricks should never be tapped or moved once it has been laid on the mortar bed. Moving the masonry unit breaks the initial bond formed between the unit and the mortar causing cracks. It is also important that the joints be tooled as it provides a watershed surface and enhances the brick mortar bond. The compression applied while tooling produces a denser area near the wall surface and rids the mortar of any hidden cavities (Roller 1994).

3.4. VOID AREA

Increasing the number of voids or area of voids could be another approach to reducing material consumptions in brick production. From previous studies it has been concluded that increasing void area had no significant effect on water penetration, flexural bond or compressive strength. The flexural and compressive strength depends on the material used and the method of production. However in one of the studies it was concluded that higher void area amounted to higher consumption of mortar during construction (Sanders & Brosnan, 2007). Further investigation needs to be conducted to decide whether higher material consumption in brick production or higher mortar construction is better in terms of environmental and economic impacts.

4. LABORATORY TESTS

4.1. WATER PENETRATION TESTS

For this study, the two brick samples, a standard one and a thinner one were chosen. The standard brick will be referred to as Series “0” and the thinner one will be referred to as Series “1” from this point in the paper. Three mock up walls were built for each brick sample using Type N mortar. The wall specimens for Series “0” have been denoted as A0, B0 and C0 and the wall specimens for Series “1” will be denoted as A1, B1 and C1 henceforth. These walls had been initially tested two years ago and the results from the initial tests were used in the analysis.

The water penetration tests were carried out as prescribed by the ASTM E 514 standard. Each wall specimen was built to a size of approximately 1500mm X 1500mm and the face side was parged all around leaving a test area of about 1.08m². The purpose of parging the side was so as to allow an air tight seal with the pressure/water chamber.

The test equipment consisted of the pressure/ water chamber and the water control panel. The pressure/ water chamber is attached to the face of the wall specimen and simulates pressure and rainfall similar to wind driven rain. The water control panel consists of all the controls that help monitor the flow of water into the chamber. It also consists of the water reservoir. As per the standard the water flow was maintained at 155l/hr and the pressure was maintained at 500 Pa for the initial set of testing. Figure 2 shows the entire test setup.

Each test was conducted for a period of four hours during which readings of water collected behind the wall were taken at half hour intervals. The wall specimen would be measured before and after the tests as the difference in weights would give us the amount of water that had been absorbed by the wall. After the initial round of tests, it was decided to test some of the walls again. The tests would be different this time as the initial moisture content in the walls would be higher.

After the initial testing of the walls as per ASTM 514 standards, a second set of tests was conducted by reducing the rate flow of water to 80l/hr. from 155l/hr. The flow was reduced to half of the original value in order to find the amount of water that higher pressure would drive through in the event that less water hits the facade. In reality the amount of water on a building facade would be much greater under such high pressure. For the third set of tests, the pressure was reduced from 500Pa (equivalent to wind speed of 100km/hr.) to 120Pa (equivalent to wind speed of 50km/hr.), as it represents wind speeds prevalent during rain showers (Anand, Vasudevan & Ramamurthy 2003).



Figure 3: Water Penetration Test Setup as per ASTM 514 standard



Figure 4: Absorption Test setup

4.2. PHYSICAL PROPERTIES AND VOID AREA MEASUREMENTS

Five specimens were randomly chosen from each type of brick for sampling and for the various laboratory tests as per ASTM C67 standards. The chosen specimens were checked for any visible damage like chipping, warpage etc. The specimens were each then properly marked and numbered. The following parameters were then measured- length, width, height, weight, face shell thickness and void area.

4.3. ABSORPTION TESTS

The absorption tests were carried out to evaluate the absorption characteristics of both bricks. After the initial water penetration tests it was noticed that Series “1” brick veneer walls absorbed quite a large amount of water. This result was quite unexpected and so it was decided to investigate the absorption properties of the bricks. As seen in figure 3 an absorption test set up was created using a rectangular tub and steel angles to hold the bricks in place. Five brick unit specimens were tested from each series

ASTM C67 and ISO 1418 standards were used to determine the absorption properties of the brick samples. All brick samples were checked for chips and loose debris and wiped clean before commencing the tests. To determine the Initial Rate of absorption of the bricks, each brick was first weighed to determine the dry weight, and then slowly immersed in to water for a minute. The brick was taken out, wiped off to rid of excess water and weighted to determine the wet weight of the brick. The difference in weight would give the amount of water absorbed by the brick in a minute. The same procedure was repeated for the remaining brick samples.

As for the partial and full submersion tests, the bricks were allowed to dry out completely in the lab for a few days before being subjected to testing. All the bricks were weighed before immersion into water and their dry weight was noted. These were 24 hour tests and the bricks were taken out at different intervals and readings were taken at - 5 and 20 minutes, 1, 2, 4, 8, 12 and 24 hours.

Water Flow		155l/hr.					78l/hr.		
Specimen		A		B		C	A	B	C
Pressure	No. of tests ¹	1	1	2	3	1	1	1	1
500Pa	Amount of water penetrated in litres	15.38	12.70	7.00	17.44	10.13	10.93	8.98	4.71
	Amount of water absorbed in litres	11.66	10.97	9.56	6.86	14.17	10.29	10.75	9.15
120Pa	Amount of water penetrated in litres	9.51	4.61			4.76			
	Amount of water absorbed in litres	6.86	8.23			5.72			

Table 3: Matrix showing amount of water penetrated and absorbed through wall specimens A, B and C of Sample "0" bricks

Water Flow		155l/hr.						78l/hr.		
Specimen		A		B			C	A	B	C
Pressure	No. of tests ¹	1	2	1	2	3	1	1	2	3
500Pa	Amount of water penetrated in litres	5.12	4.22	2.76	3.36	11.03	3.77	0.42	1.75	1.64
	Amount of water absorbed in litres	15.78	13.49	13.49	14.86	6.17	16.23	16.23	14.17	14.63
120Pa	Amount of water penetrated in litres	0.45		0.07			0.29			
	Amount of water absorbed in litres	11.20		9.15			8.23			

Table 4: Matrix showing amount of water penetrated and absorbed through wall specimens A,B and C of Sample "1" bricks

The two types of brick veneer walls show different levels of resistance to water penetration. While the difference in water absorbed and penetrated is not much in Series "0" walls, the difference is much bigger in Series "1" walls. The amount of water absorbed by Series "1" wall is around four times the water penetrated through them.

The results from the tests with lower water flow level and lower pressure showed a decrease in water penetration through the wall. The first drop of water was seen at the back of Series "0" walls within five minutes while it took approximately seven minutes in the case of Series "1". In case of lower pressure, it took longer for the first drops to appear- around ten minutes for Series "0" and fifteen for Series "1". Reducing the water flow by half reduced water penetration in series "0" walls by approximately one third of the penetration in the first set of tests. Sample C from series "0" and sample B from series "1" exhibited different behaviour to other two wall samples. Both these walls allowed less water through in comparison to the other samples. The amount of water penetrated through series "1" walls with lower pressure was negligible.

The Initial Rate of Absorption of Series "0" brick was found to be 13.5g/200 cm²/min while the Initial Rate of Absorption of Series "1" brick was found to be 40.6 g/200 cm²/min. This shows that the IRA of Series "1" bricks is three times as that of Series "0" brick. This could be the reason for better bond between mortar and brick in Series "1" wall specimens.

The results from the absorption tests helped determine the permeability and absorptive properties of the bricks. In the partial submersion test, it was noticed that the bricks from series "0" had not attained total saturation even after 24 hours as. At the same time bricks from series "1" absorbed much more water and also attained near saturation after four hours of partial immersion. In the full immersion test, Series "0" bricks absorbed water gradually and saturated within a period of one hour, hence while Series "1" bricks absorbed the maximum amount of water in the first five minutes of immersion and hence reached saturation point within 20 minutes. Also the total amount of water absorbed by the thinner bricks was actually more than one third of the amount of water in the thicker ones.

5. CONCLUSION

The study has demonstrated that there is great potential in adopting thinner clay brick veneer as a cladding material.

From an environmental perspective a lot can be gained by reducing the thickness of brick veneer. Lesser amounts of raw material such as clay and water would be required reducing the amount of natural material that needs to be extracted. The paper also proved that reduced thickness would not compromise the capability of the brick veneer wall to work as a rain screen.

The environmental study proved that the embodied energy of a house can be significantly reduced by 17% by slightly reducing the thickness of brick and this would multiply exponentially considering that thousands of houses are built in a year in Canada. Adopting thinner brick veneer would contribute to material reduction in other ways such as smaller foundations, less mortar etc. These possibilities have not been explored in this paper. Reduced carbon dioxide emissions would mean the brick production industry would reduce its contribution towards global warming. Similarly there would be a significant lowering of other emission like sulphur oxides, VOC's etc. Effluents such as ammonia which leads to nitrification of water bodies inhabitable are also reduced.

From the water penetration test it was clear that the thinner bricks allowed much lower amounts of water through than the standard bricks. It was observed in the initial tests when the moisture content in the walls were negligible, the walls absorbed more water than they allowed through.. Subsequent test results showed lesser amount of water was being absorbed with higher initial moisture content of the walls. Hence once the walls are wetted, the amount of water that penetrates the wall increases.

All the previous studies that were reviewed pointed out that the Initial Rate of Absorption plays a crucial role in the bond that is formed between the brick and the mortar at the time of laying the bricks. The results from the IRA tests showed that the IRA value of the thinner bricks was in fact approximately three times higher than that of the standard bricks. This can be confirmed from the fact that for all the water penetration tests, the water always appeared almost instantly through the joints in the standard bricks while it took a little longer in the thinner ones. This is a clear sign that there were cracks or minute openings in the joints of Series "0" walls.

Comparing with the results from the earlier study (Straka & Gorgolewski 2009), to the new results confirms the lesser water penetration compared to the other samples in the series. This was related to the fact that the same batch of mortar was used in both these walls. The results in the new tests also confirmed that these two wall specimens did perform better than the other walls. It was realised that all the walls from both brick samples performed better this time.

There are various clay products available, such as clay tile panels which are also designed as rain screen walls and seemingly used less materials. These panel systems however have much more complicated backup systems that cost more and utilise steel or aluminum framing which increases the embodied energy of these systems. These systems also tend to be much more expensive and require specialized labour. Due to these reasons, brick veneer is one of the most commonly used and cheapest form of cladding adopted in housing. Improving the design of the brick veneer is therefore an important and vast area of interest and from this study it has been proved that there is potential in thinner veneer walls.

6. CONCERNS REGARDING REDUCTION OF BRICK VENEER THICKNESS

Adopting thinner brick veneer would reduce the overall load on the structure of the building. This could possibly lead to more savings in material used in the foundation and framework. On the other hand, the number of anchors between the veneer and the frame might have to be increased to keep the veneer firmly attached to the frame (Straka & Gorgolewski, 2009). Further research must be done to investigate whether the thinner bricks can be used in multi residential apartment buildings of more than three storeys. Due to lesser thickness, thinner brick veneers might not be suitable for greater floor to floor heights as it may not be able to support its own weight. Reducing the thickness of the veneer may have negative effect on the thermal performance of the building envelope (Straube

J. F. 1998). Detailed analysis of rain screen brick veneer wall performance subjected to actual climatic conditions would have to be done in order to address the impact of thinner veneer on energy performance. The field study may be required as the cavity, its thickness and ventilation play a role in the wall thermal resistance. Other factors need to be taken into consideration is the effect reducing the thickness of brick has on fire resistance, sound transmission etc. (Straka & Gorgolewski 2009).

7. FURTHER STUDY

In terms of replacing standard brick veneer with thinner ones it is necessary to look into factors such as durability, sound transmission and fire resistivity. More research needs to be done on these factors and how they would be affected. Another important question would be the structural integrity of thinner veneer and its performance under the wind load. Both brick samples have different physical properties but are recommended for the severe weather in Canada.

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ENDNOTES

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Empirical aesthetics: the body and emotion in extraordinary architectural experiences

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ABSTRACT:

While there have been many theoretical and philosophical speculations on the role of emotion and embodiment in the aesthetic experience of architecture, there have been little or no actual empirical support substantiating the claims made. If this lack of hard proof was not an issue in the past, our epoch, profoundly influenced by Modernity, has made increasingly difficult to advance any significant allegation without providing some factual evidence in the scientific sense. This paper reports on work directed to address this challenge. Using a previously documented survey on Extraordinary Architectural Experiences, a large quantity of 'qualitative measurements' was collected along 13 categorical variables gauging feeling and embodiment. These data were then thoroughly examined through four levels of statistical analysis. The results empirically demonstrate 69 significant correlations among the variables and thus the central role of embodiment and emotion in extraordinary architectural experiences. Of these correlations, 23 were specifically analyzed to define their psychological and physical characteristics to an unprecedented level of detail. It is hoped that this knowledge sets up a foundation from where to test, develop, and/or apply old and new hypotheses of aesthetic affect and effect in architecture.

CONFERENCE THEME: On Measurement

KEYWORDS: aesthetics, phenomenology, feeling, embodiment, survey

INTRODUCTION

This paper reports on the central role that embodiment and emotion play during the highest aesthetic encounters with architecture using statistical analyses of a massive survey of Extraordinary Architectural Experiences¹ (EAEs) conducted between in 2007-2008.

Aesthetics has been one of the hardest areas to give in to the pleas for scientific validation. Quite simply, these events involve unobservable phenomenology occurring in the seemingly impenetrable subjective box of embodied consciousness. The record of efforts geared toward addressing this situation is poor even we consider the Gestalt psychology of the first half of the 20th Century or the focused studies conducted by behavioral and cognitive psychology of the last 50 years. The limitations of this work come from dealing with ordinary perception defined within a narrow and basic level of operation that not only avoids aesthetics and the extraordinary but also has little application for architecture. The investigations on the semiotics and phenomenology of the built environment during the 1980s and 1990s (Krampen 1979, Norberg-Schulz 1985, 1971, Rapoport 1982, Robinson 2006, Seamon 1993, Tuan 1977) targeted this knowledge gap using 'meaning' as its main focus of inquiry — thus addressing larger and more holistic, symbolic and cognitive responses to architecture. While there is no question that these studies delivered valuable insights, their approach was largely directed toward ordinary engagements of buildings and therefore left untouched the most precious and significant experiences of architecture. The fact that there is very little published information either describing or even just acknowledging the highest aesthetic reception of architecture is a case in point (Bermudez 2009b). When scholars have tried to address them (Perez-Gomez 2006, Jones 2000), the highly qualitative nature of the phenomenon made them return to pre-modern methods of reasoning, hermeneutics or poetic narrative, thus failing to respond to contemporary demands for scientific scrutiny.

The work reported in this paper responds to this situation by judiciously using science to investigate

our most exceptional encounters with architecture. In this sense, it shares commonalities with Experimental Philosophy (“X-Phi”), a new and growing reflective practice focused in applying empirical examination to issues that have resisted scrutiny on the basis of analytical reasoning, phenomenological inaccessibility, and/or distrust of science (Knobe & Nichols 2008). This research is also related and finds inspiration in another emerging area of scientific-philosophical scholarship and debate around the matters of “qualia” (Chalmers 1995, Dennett 2005, Mogi 2010).

I. PREVIOUS SURVEY FINDINGS SUPPORTING THIS STUDY

Bringing the experimental rigor of science to illuminate the aesthetic reception of architecture meant to design and conduct two independent and identical surveys (in English and Spanish). The goal was to collect a substantial number of responses so that the data could be statistically studied. The polls were freely accessible on the internet for one year (April 2007 to April 2008) and gathered the largest number of personal accounts of EAEs ever collected (1,890 in English and 982 in Spanish). I will not here expand on the rationale, details, and decisions shaping the Survey nor the responding population characteristics. This information is available elsewhere (Bermudez 2011, 2010, 2009a, 2008).

In order to facilitate the readability of the results, responses to the English survey will be formatted in **bold** whereas answers to the Spanish poll will be in italics. Given their identical nature, from now on, when I say ‘survey’ I will be referring to both at once.

The reason for looking in depth at embodiment and emotion in EAEs come from the findings of the first round of analyses of the survey data. Asked to select five main qualities describing their exceptional aesthetic event (using a list of eight words —*alert, analytical/intellectual, emotional, graceful, personal/private, pleasurable, sensual/perceptual/physical, timeless*; and/or entering up to three of their own), participants of the poll agreed in the top four characteristics:

“Emotional” (70.5%, 76.5%),

“Sensual/Perceptual/Physical” (71%, 50%),

“Timeless” (50%, 37%), and

“Pleasurable” (41%, 38.5%)

The very high ranking of “Emotion” in comparison to all the other experiential descriptors in the Spanish responses suggests that, for this population, the arrived internal state (i.e., the effect of architecture in the person) is central to the experience, and probably what drives and brings everything together into a coherent phenomenology. Although the English population also ranks “Emotion” very high, there is a tie with “Sensual/Perceptual/Physical” suggesting a balance between internal and external foci. The very high ranking of the sensible/corporeal/material by both groups not only confirms the fundamental (and obvious) role that the observable play in the aesthetic reception of architecture but when coupled with feelings strongly point at the intimate intertwining of the sensual and the emotive. In short, the top two qualifiers affirm that EAEs are first and foremost perceptive engagements directed in two ways: outwardly (perceptions done by the senses—*sensibility*) and inwardly (perceptions gauged by feelings—*sentientcy*), both unavoidably tied to the body.

Casting further light on the role of embodiment and feelings in EAEs demands to briefly consider the third and fourth descriptors in the context of a fifth. “Pleasure” recognizes the delight born out of experiencing architectural qualities whereas “Timelessness” insinuates a dramatically slowed-down event of a meditative kind, able of more heightened experiences. Notice that someone could argue for a less ‘fleshy’ phenomenology, one that delivers instead intellectual “pleasure” and “timelessness” —something that no doubt occurs and many of us have enjoyed. However, the low **fifth** and **sixth** ranking of the descriptor “Analytical/Intellectual” (**36%**, *34.5%*) in the survey implies that cerebral (i.e., detached) activities play a secondary role in EAEs. Actually, the statistical study of only those responses with “analytical/intellectual” as their main qualifier (i.e., **100%**, *100%*), still finds “Sensual/Perceptual/Physical” (**73%**, *56.2%*) and “Emotion” (**67.7%**, *81.8%*) in second and third place, followed by “Timelessness” (**47.5%**, *35%*) and “Pleasure” (**42.2%**, *43.3%*). In other words, survey participants state that mental operations during EAEs are not running the experience but instead playing along, in a background or supporting role. Emotions and body, however, remain central to this phenomenology.²

More evidence supporting the important function of embodiment and feelings in EAEs come from responses to specific questions addressing them and included in the poll. The survey data overwhelmingly depict EAEs as intense (80%, 88.5%), profound (89%, 91.5%), and vivid (85.5%, 84.5%) phenomenologies that are likely to start suddenly (51.5%, 58.5%) and surprisingly (76%, 83%), and run spontaneously (78.5%, 91%). Not only are they not too stable (46.5%, 47%) or controllable (44%, 55%) but unlikely to finish at one's will (33%, 37%). More 'spectacular' is the literal performance of the body during EAEs. Survey respondents acknowledge the regular presence of strong corporal reactions (56.5%, 43%) and that one in 5/3 EAEs wept — an extreme form of physical response. Given this level of emotional and corporal arousal, it is not surprising that EAEs were said to remain very strongly imprinted in memory (63.5%, 63.5%) and considered as or more powerful than other extraordinary life experiences (91.5%, 77%).

2. METHODOLOGY

The survey devoted 13 questions to gauge embodiment and emotion during EAEs (See Appendix 1). Four consecutive statistical analyses were applied to the collected data. The first was a general examination and produced using the mathematical engine of *StudentVoice* —the online survey provider contracted to encode the questionnaire and then collect and organize the data entered by the participants (www.studentvoice.com). The information provided above comes from this first level of study (Analysis #1).

The second analysis consisted of *Pearson's Chi-Square* tests of each variable. The objective was to verify that there was a significant difference in the probability of answering one way or another to a particular question. The third round of statistical analysis also resorted to *Chi-Square* tests but studied the associations between the 13 variables to determine if there existed correlations between them. *Given* the nature of the test, this has to be done two at a time. Following standard statistical practices a *probability p-value* equal or below 5% (0.05) was recognized as reliable significance.³ Lastly, since a *Chi-Square* test does not define the strength and nature of a relationship (only that there is a significant one), the fourth study considered such interaction using a descriptive statistical query. This was done by 'segmenting' the survey data by means of *StudentVoice* statistical software. This analysis allowed the comparison of, for example, how those responding "yes" or "no" to a particular question answered a second question, thus illuminating their correspondence at a higher level of statistical resolution.

3. SIGNIFICANCE OF THE VARIABLES OF EMBODIMENT & EMOTION IN EAES

Of the 13 mentioned questions (Appendix 1), there were 9 designed to directly gauge emotion and embodiment and 4 to provide supporting evidence. Below are the 9 main categorical variables. In parenthesis are the p-value obtained thru the significance test. The underlined number is the p-value calculated on the data combining English and Spanish survey results.

Body reactions (**0.00**, 0.073, 0.00)

Weeping (**0.00**, 0.00, 0.00)

Speed of Arousal —Sudden or Gradual (**0.00**, 0.193, 0.00)

Type of Arousal —Surprising or Expected (**0.00**, 0.00, 0.00)

Experiential Stability (**0.00**, 0.12, 0.00)

Intensity (**0.00**, 0.00, 0.00)

'Profoundity' (**0.00**, 0.00, 0.00)

Vividness (**0.00**, 0.00, 0.00)

Spontaneity (**0.00**, 0.00, 0.00)

The 4 indirect categorical variables are:

Controllability (**0.34**, *0.00*, 0.20)

Willful Ending (**0.00**, *0.14*, 0.00)

Comparison with other 'very strong life experiences' (**0.00**, *0.00*, 0.00)

Fresh/Vivid Recall (**0.00**, *0.00*, 0.00)

The results of the Chi-Square tests support the significance of the responses to all the variables except in the Spanish responses to “Body Reactions”, “Speed of Arousal”, “Stability”, and “Willful Ending”. In the case of “Body Reaction”, we can make waive a strict statistical interpretation given the overall survey results, the strong response given to this same question by the English participants, and (fundamentally) the borderline condition of the p-value (0.073, or 92.6% confidence). It should be noted that when we compound the English and Spanish results for each of the ‘troubled’ variables (i.e., we consider them as a whole), the variables pass the significance test. More problematic is “Controllability” in the English survey since not even compounding the dataset delivers enough significance. While this could be a serious problem if we studied it (or any of the other) specifically, the fact that a particular variable does not return significance does not require its elimination from a correlational study (Analysis #3 next).⁴ In the end, most of the variables did pass the Chi-Square test which means that they can be trusted to deliver significant responses within their area of application (i.e., the question itself). This outcome also validates the general roster of questions devoted to probe into this matter. We only need to be cautions when we look at the data within any of the four variables with high p-values.

4. SIGNIFICANT CORRELATIONS AMONG THE 13 VARIABLES

We will next consider the correlations among these 13 variables using the Chi-square test. Chart 1 shows a summary in a visually friendly format. Those interested in seeing the actual p-values may refer to Chart 2 in Appendix 2.

Of the 72 possible correlations, there are only 3 cases where no relationships between variables were found, 17 have split results (either English or Spanish data bear no dependency between variables),

	Sudden	Surprising	Weeping	Body Reactions	Stability	Intensity	Profoundity	Vividness	Spontaneity	Controllability	Willful Ending	Comparison	Vivid Recall
Sudden		+	+	+		+	+	+	+	+	+	+	+
Surprising	+		+	+		+	+	+	+	+	+	+	+
Weeping	+	+		+	+	+	+	+	+	+	+	+	+
Body Reactions	+	+	+		+	+	+	+	+	+	+	+	+
Stability			+	+		+	+	+	+	+	+		+
Intensity	+	+	+	+	+		+	+	+	+	+	+	+
Profoundity	+	+	+	+	+	+		+	+	+	+	+	+
Vividness	+	+	+	+	+	+	+		+	+	+	+	+
Spontaneity	+	+	+	+	+	+	+	+		+	+	+	+

Chart 1: Summary of Chi-square test results analyzing the dependency or independency among the 13 variables (study done in pairs). A “+” means that there is correlation between the variables (i.e., p-value < 0.05). A black box communicates no correlation between the variables (i.e., p-value > 0.05). A black triangle represents no correlation in the result of the English (if on the left side) or Spanish (if on the right side) survey.

and 52 show variable correlations that are agreed by both survey groups. Overall these results fair well in terms of the appropriateness of the chosen dimensions to gauge the phenomena. Should there have been widespread independency among the variables, we would have concluded that there were no significance or relevancy in the variables used to measure the event in the first place.

“Spontaneity” and “Profoundity” have the most number of correlations with other variables (11.5 of 12 possible) with only one negative—with the Spanish “Weeping” and English “Controllability” respectively. This means that both play an important role in attaining and/or sustaining EAEs in general and embodiment and emotion in particular. Second in cross-correlational impact are “Intensity”, “Weeping” and “Sudden Arousal” with 11, 10.5 and 10 correlations of the 12 possible, respectively. After that, “Body Reactions” and “Vividness” follow with 9.5 and last come “Surprising” and “Stability” with 9 and 8.5.

This ranking is only relatively useful because it is very different when we consider either the Spanish or English data in isolation. In fact, all but 1 of the 17 split correlations come from statistical ‘rejections’ of the Spanish survey variables. Without going into a discussion of the effect or impact of language and culture in EAEs, body and feeling (a topic to be covered in the future), it is evident that there are important differences. It is important to note, however, that “Body Reactions” is one the variables displaying most differences between Spanish and English responses. Let us note that Spanish survey respondents reported body reactions in less than one-half of their EAEs (much less than English speakers). It is this particular response that sets up much of the discrepancies between the two groups in terms of the topic that preoccupies us here. However, if we now turn our attention to “Weeping” we will observe a reverse pattern. Here Spanish speakers acknowledge a much higher level of expression than the English group. We can speculate that, perhaps, it is this higher facility to let themselves cry that lessen the body reactions of Spanish survey participants. Possibly by repressing tears, Anglo-speakers channel their heightened emotional state into the body—effects that are socially invisible and therefore more acceptable within their cultural milieu (Elkins 2001). For this reason, a much better measurement of the literal reactions of the body could be to combine “Body Reactions” and “Weeping”. When we remove all overlapping between EAEs said to have both of them at the same time and add up EAEs reported to produce either one, the percentage of explicit and dramatic corporal manifestation goes up to **60.7%** and **58.9%**.

We should not allow these correlation discrepancies between Spanish and English surveys to obscure the fact that, on the whole, there is much overlap between the two groups: 55 agreements against only 17 disagreements. This is a 66% coincidence. This considerable commonality provides a good foundation from where to board the next level of analysis.

5. STATISTICAL DESCRIPTIVE STUDY OF 23 CORRELATIONS

Having established the universe of statistically correlated variables, we can look more closely at the relationships themselves. This means that we must bring comparative statistical studies to consider the likely nature and strength of the relationship (Analysis #4). Notice that the relationship needs to be considered from both sides. Since a detailed discussion of the 52 common (English-Spanish) correlations would not fit the length of this paper, I will present 23 that exhibit powerful interactions in terms of directionality and strength. We will follow the format sketched above: first the statistical result, then a short interpretive analysis followed by a conclusion. An “*” means that the particular statistics that precedes it were not found significant by Analysis #2 and therefore can only secondarily assist our reading. The statistical results will be summarized in the following format:

VARIABLE 1 < > VARIABLE 2

Variable #1 and Variable #2 (Difference between (a) and (b); (a) Response to Variable #2 by those that answered YES to Variable #1 versus (b) Response to Variable #2 by that those that answered NO to Variable #1)

Variable 2 and Variable 1 (Difference between (a) and (b); Response to Variable #1 by those that answered YES to Variable #2 versus Response to Variable #1 by that those that answered NO to Variable #2)

Let us now move into the presentation of the findings. When appropriate (i.e., similarities), I have included two or three correlations together.

BODY REACTIONS < > WEeping

Body Reactions and Weeping (+16.9%; 24.5% vs. 7.6%) (+20.2%; 36.6% vs 16.4%)

Weeping and Body Reactions (+28.7%; 79.3% vs. 50%) (+36.5%; 68.3% vs 31.8%)

Analysis: EAEs with body reactions involve **three/two** times more weeping than those without any corporal sensations. On the other hand, EAEs that cause crying generate more body reactions than those that don't (**one-and-a-half/two** times as much).

Conclusion: there is a strong positive correlation between body reactions and weeping, with the former taking the lead. The more body reactions the more likelihood of weeping.

BODY REACTION < > PROFUNDITY / BODY REACTION < > SPONTANEITY

Body Reactions and Profundity (+6.5%; 91.6% vs 84.1%) (+10.8%; 96.4 % vs 85.6%)

Profundity and Body Reactions (+14.3%; 58 % vs 43.7%) (+30.1%; 45.5% vs 15.4%)

Body Reactions and Spontaneity (+12.1%; 83.6% vs 71.5%) (+10%; 94.2 vs 84.2%)

Spontaneity and Body Reactions (+18.8%; 60.7% vs 41.9%) (+25.9%; 45.9% vs 20%)

Analysis: while the presence of body reactions indicate increasing profundity/spontaneity, profundity/spontaneity has a much bigger effect in eliciting body responses. In other words, a profound or spontaneous experience will tend to cause body reactions more readily than corporal sensations catapult oneself into a profound or spontaneous phenomenological state.

Conclusion: there is a positive correlation between body reactions and experiential depth/spontaneity but it is the latter which most likely holds the initiative.

WEeping < > INTENSITY / WEeping < > PROFUNDITY

Weeping and Intensity (+15.3%; 92.2% vs 76.9%) (+14.2%; 96.1% vs 81.9%)

Intensity and Weeping (+13.4%; 20.3% vs 6.9%) (+29.7%; 39.2% vs 9.5%)

Weeping and Profound (+8.3%; 95.7% vs 87.4%) (+9.5%; 97.1% vs 87.6%)

Profound and Weeping (+13.3%; 19% vs. 5.7%) (+25.3%; 29.1% vs 3.8%)

Analysis: while weeping foretells intensity and profundity, it is intensity/profundity the one most likely to cause weeping (by increasing 3, 4 and even 8 times its occurrence from not-intense or not-profound experiences).

Conclusion: there is a positive correlation between weeping and experiential intensity/profundity but the relationship depends on intensity/profundity to provoke weeping.

BODY REACTIONS < > STABILITY / BODY REACTION < > CONTROL

Body Reactions and Stability (- 11.4%; 41.5% vs 52.9%) (-16.7%; 34.6% vs 51.3%)

Stability and Body Reactions (-12.5%; 50.4% vs 62.9%) (-18.7%; 29.3% vs 48%)*

Body Reactions and Control (-19.4%; 36% vs 55.4%) (-21.1%; 52.7% vs 31.3%)

Control and Body Reactions (-20.6%; 45.9% vs 66.5%)* (-21.2%; 31.5% vs 52.7%)

Analysis: EAEs with body reactions are felt less stable than those without and vice-versa: those reporting higher experiential stability witness less body reactions than those acknowledging instability. Similarly, EAEs with body reactions are felt less under control than those without dramatic corporal

sensations. In fact, the more one wants to assert control on the experience, the less the probability of witnessing any corporal effects. The similarity of results between the two populations regarding “Stability” and “Controllability” ease a bit the doubts of considering the not significant variables marked with a “*” (analysis #2).

Conclusion: there is a strong but fairly balanced negative correlation between Body Reactions and Stability/Control.

Commentary: Notice that controllability here necessarily implies conscious volition, that is, an ‘intellectual’ decision to manage the situation. Since body reactions cannot be truly willed into being, it is natural to find this lack of correlation. It is probable that body reactions are part of what makes the experience ‘instable’ and felt ‘out-of-control’, that is, beyond the range of normal behavior, perception or psychological response.

INTENSITY < > STABILITY

Intensity and Stability (-15.3%; 43.5 % vs 58.8%) (-17.6%; 42.9% vs 60.5%)

Stability and Intensity (-8.1%; 74.8% vs 82.9%) (-16.1%; 81.8% vs 97.9%)*

Analysis: consistently with Stability < > Body Reaction, intensity seems to preclude stability. The more intense an experience, the more instable it is felt. This also suggests the existence of a positive correlation between intensity and body reactions, something statistically proven in the English survey responses but not in the Spanish poll (See Chart 1 and 2). Results of the correlation statistics of the Spanish data that begins with “Stability” needs to be seen with suspicion due to “*”.

Conclusion: there is a negative correlation between stability and intensity in EAEs that shows either balance (Spanish data) or intensity leading (the English group).

INTENSITY < > SUDDEN AROUSAL / INTENSITY < > SURPRISE

Intensity and Sudden Arousal (+19.5%; 53% vs 43.5%) (+19%; 55.4% vs 36.4%)

Sudden Arousal and Intensity (+11.8%; 85% vs 73.2%) (+8%; 92.4% vs 84.5%)*

Intensity and Surprising (+8.5%; 76.4% vs. 67.9%) (+16%; 76.5% vs 60.5%)

Surprising and Intensity (+2.5%; 81% vs 78.5%) (+13.8%; 91.2% vs. 77.4%)

Analysis: Intensity is a better predictor of sudden arousal and surprise than a rapid onset of the experience or its being surprising. The fact that EAEs unfold at high intensity has a marked influence in this correlation. Notice that surprise plays a more subtle role in English speakers than in Spanish speakers. Spanish statistical results of the impact of suddenness on intensity are very soft as they occur within a variable not showing significance (analysis #2)

Conclusion: there is a positive correlation between Intensity and Sudden Arousal/Surprise with the former likely to provoke the latter.

SUDDEN AROUSAL < > SURPRISING EXPERIENCE

Sudden Arousal and Surprise (+8.5; 78.7% vs 70.2%) (+10%; 89.9% vs 79.9%)*

Surprise and Sudden Arousal (+10.4%; 61.5% vs. 51.1%) (+19.4%; 55.3% vs. 35.9%)

Analysis: Sudden EAEs are reported to be more surprising than gradual EAEs (+8.5%, +10%) and vice versa: surprising EAEs tend to arise more suddenly than those expected (+10.4%, +19.4%). The fact that answers to “Sudden Arousal” were not found statistically significant in the Spanish survey (Analysis #2) diminishes our ability to count otherwise strong numbers towards measuring the strength of the interaction between these two variables. As a result, we must opt for a balanced strength.

Conclusion: there is a positively balanced correlation between Sudden Arousal and Surprise.

BODY REACTIONS < > SUDDEN AROUSAL

Body Reactions and Sudden Arousal (+15%; 65.2% vs 50.1%) (+14.6%; 60.3% vs 45.7%)

Sudden Arousal and Body Reactions (+14.9%; 62.4% vs. 47.5%) (+13.5%; 49.8% vs.36.3%)*

Analysis: sudden arousal provokes more body reactions than a gradual beginning. At the same time, experiences causing body reactions arrive more suddenly than those that do not. Despite this balance in numbers (one of them not too trustable due to “*”), it stands to reason and experience that suddenness may have a slight phenomenological lead over body reactions.

Conclusion: there is a strong positive correlation between Body Reaction and Sudden Arousal with the latter more likely to take the lead.

INTENSITY<> PROFOUNDITY / INTENSITY <>VIVIDNESS /

PROFOUNDITY<>VIVIDNESS

Intensity and Profound (+12.4%; 91.7% vs. 79.3%) (+19.4%; 93.8% vs. 74.4%)

Profound and Intensity (+23.6%; 82.2% vs 58.6%) (+26.5%; 90.1% vs 53.6%)

Intensity and Vividness (+11.8%; 88.2% vs. 76.4%) (+11%; 85.4 % vs 74.4%)

Vividness and Intensity (+16.5%; 82.64vs 66.1%) (+20%; 88.5% vs 68.4%)

Profound and Vividness (+9.5%; 87.5% vs 77%) (+35.1%; 86.9% vs 51.8%)

Vividness and Profound (+10.6%; 91.3% vs 80.7%) (+23.3%; 94.3% vs 71%)

Analysis: Since EAEs are overwhelmingly described as intense, profound, and vivid, we would expect that the presence of one of these qualifiers will call forth the others. The statistics support this expectation. EAEs considered intense are more profound and vivid than those not reported as intense. EAEs experienced as vivid are felt more profound and intense than those not vivid. And profound EAEs are more intense and vivid than those not experienced as profound. However, this three-way relationship is not totally equal. Our descriptive statistics suggest that profundity has a bigger impact on the others than those on it.

Conclusion: there are positive correlations among Profoundity, Intensity and Vividness with the former having more impact on the latter two than vice-versa.

Commentary: while these three experiential dimensions have visceral, emotional, and mental implications, their first and most clear effect is felt rather than thought, sensed rather than reasoned, and immediate instead of mediate. In other words, they are clear signs of embodiment and emotion.

SPONTANEITY

Commentary: Spontaneity is the art of being natural or unburden of preconceived notions of how things ought to be so that a given situation is let happen as it will. It is an oxymoron to control spontaneity although it is possible to manage oneself to facilitate its progress. However such act is one of surrendering control, in other words steering oneself away from steering. Spontaneity is hard to describe or explain but we all know it when we see or feel it. Spontaneity can be most readily and naturally expressed through our body and emotions. While it is possible to be intellectually spontaneous, it takes quite a bit of skill and is therefore not common. Since spontaneity is correlated with 11.5 of the 12 variables, embodiment and feelings permeate and define EAEs thoroughly.

SPONTANEITY <> SUDDEN AROUSAL

Spontaneity and Sudden (+21.5%; 63% vs 41.5%) (+33.4%; 55.6% vs 22.22%)

Sudden and Spontaneity (+14.2%; 84.5% vs 70.3%) (+8.7%; 95.5% vs 86.2%)*

Analysis: spontaneous EAEs are one-and-a-half/two times more likely to start suddenly than those that are not. The reverse holds true in direction (more sudden phenomenologies were more

spontaneous) but not in power. While the little trustable “*” Spanish statistics manage to match the statistical direction/strength of its English counterpart, it doesn't provide us with enough confidence to make a final determination.

Conclusion: there is a positive correlation between Spontaneity and Sudden Arousal with the former likely to affect the latter more substantially than vice-versa.

SPONTANEITY <> SURPRISE

Spontaneity and Surprise (+27.6%; 81.6% vs 53%) (+17.9%; 88% vs 61.1%)

Surprise and Spontaneity (+27.9%; 84.8% vs 56.9%) (+21.1%; 93.7% vs. 72.6%)

Analysis: spontaneous EAEs are significantly more surprising than not spontaneous phenomenologies. The reverse is true. Surprising experiences encourage more spontaneity than those that are not. The two variables are very much tied in weigh.

Conclusion: there is a balanced positive correlation between Spontaneity and Surprise.

SPONTANEITY <> INTENSITY / SPONTANEITY <> PROFUNDITY /

SPONTANEITY <>VIVIDNESS

Spontaneity and Intensity (+17%; 83.8% vs 66.8%) (+9.2%; 89.2% vs 80%)

Intensity and Spontaneity (+19%; 82 %vs 63%) (10.9%; 91% vs 79.1%)

Spontaneity and Profound (+5.1%; 90.4% vs 85.3%) (+12.5%; 92.5% vs. 80%)

Profound and Spontaneity (+11.9%; 79.7% vs. 67.8%) (+18.7%; 91.1% vs 72.4%)

Spontaneity and Vividness (+6.1%; 86.7% vs 80.6%) (+24.6%; 86.4% vs 61.8%)

Vividness and Spontaneity (+12.1%; 79.4% vs. 67.3%) (+8.5%; 84.8% vs 76.3%)

Analysis: Although there exists a clear dependency between Spontaneity and Intensity, Profoundity or Vividness, Analysis #4 suggests that spontaneity may be more easily facilitated by any of the three (with the exception of Vividness for the Spanish group) instead of the other way around.

Conclusion: there is a positive correlation between Spontaneity and Intensity/Profoundity/Vividness with the latter having a slightly stronger effect on the former.

SPONTANEITY <> CONTROL / SPONTANEITY <> END AT WILL

Spontaneity and Control (-41.1%; 34.5% vs 76.6%) (-45.1%; 43.8% vs 88.9%)

Control and Spontaneity (-28.2%; 62.7% vs 90.9%)* (-19.9%; 78.1% vs 98%)

Spontaneity and End at will (-26.5%; 27.6% vs 54.1%) (-22.9%; 31.4% vs 54.3%)

End of Will and Spontaneity (-18.6%; 66.5% vs 85.1%) (-13.1%; 80.2% vs 93.3%)*

Analysis: Terminating an EAE at will and having it under control are at the opposite end of experiential spontaneity. Thus, not surprisingly, we find the data and statistics backing up common sense once again (giving more reassurance that this quantitative analysis of qualitative matters is not so far from the mark). Spontaneous experiences are less than one-half as controllable as those not-spontaneous. Controlled phenomenologies are one third/quarter as spontaneous as of those not under control. Similarly, willful ending happens one half/third times less often than when the EAE is running spontaneously. Let us notice that descriptive statistics marked as “*” may be only secondarily considered as they failed the internal significance test (Analysis #2). However, their numbers coincide with those of the other group (not statistically compromised) and common sense.

Conclusion: there is a strong negative correlation between spontaneity and experiential Controllability/Willful Ending in which the former has much more impact on the latter than vice-versa.

CONTROL <> STABILITY

Control and Stability (+20%; 55.5% vs 35.5%)* (+23.4%; 57.7% vs 34.3%)

Stability and Control (+19.3%; 53.5% vs 34.2%)* (+23.4%; 63.5% vs 40.1%)*

Analysis: the descriptive statistics behind this correlation prove common sense right: exercising control over an experience (i.e., monitoring and steering it toward some consciously desired outcome) creates phenomenological stability. Given the relation of these two variables with other more emotionally and physically bound variables, they provide us with a good reminder of the weak influence that mental/conscious management play in EAEs. Results marked with an “*” need careful interpretation since their internal statistics were found not significant (Analysis #2).

Conclusion: there is a strong and balance positive correlation between experiential Stability and Control.

Commentary: corporal reactions and weeping are supreme literal examples of how the extraordinary exalts us to a point that totally bypasses volitive control: it is very hard (often impossible) to consciously command oneself to have goose bumps, shivers, or weep.

CONCLUSION

By bringing together a massive quantity of ‘qualitative measurements’ along categorical variables and then carrying out a four-level statistical analysis, this work is able to empirically demonstrate the significance of emotion and embodiment in exceptional architectural aesthetics. Additionally, the specific study of 23 correlations begins to map the psychological and physical effects of these experiences to an unprecedented level of phenomenological detail. Since no such empirical map existed before, this representation constitutes a big step forward. Yet, much is ahead. Next steps include the study of the remaining 29 correlations found to be significant by both groups as well as the 17 that only one of them did. Additionally, cross-relational analyses of the one-to-one dependencies and their characteristics need to be undertaken in order to build a larger and more accurate empirical depiction of EAEs. In this sense, even though Analysis #4 points at the direction and strength of a correlation, it is not statistically perfect. For this reason, a full completion of this study would demand correlational analyses among all the categorical variables at once using more powerful and sophisticated statistical methods and tools than those I used here (as available in SPSS—a complex and robust software with high statistical capabilities).

All things considered, however, we must keep in mind that this empirical mapping works on probability and not certainty. In other words, there will be phenomenologies that defy the statistical model. Such occurrence will not negate its validity. For example, some EAEs do unfold non-spontaneously and with little intensity but this doesn’t deny the fact that the opposite is much more common or natural as clearly demonstrated by the results from this research. Here lies the rationale for this type of work: to deploy methods, collect data, and produce findings that convincingly demonstrate that certain properties, attitudes, approaches, and qualities, characterize a phenomenon more likely than others. And while such scientific effort could be accused of dissecting the frog (thus killing it and with it all possibility of appreciating its very life), there is also no denying that dissections do deliver quite important knowledge that often benefit both the frog and our understanding of it. I am not here saying that this ‘dissection’ will either fully explain or make us experience the embodied and emotional nature of an EAE but it will surely help us advance our comprehension. There is room and necessity for a respectful dialogue between phenomenology and science. This is what a science of ‘qualia’ and X-Phi are all about, as said earlier.

Lastly, it is hoped that this approach and the generated knowledge will strengthen our ability to validate theoretical/philosophical claims made elsewhere. For example, it is already clear that this study affirms many of the arguments advanced by Mearleau-Ponty (1962) in terms of the central role that sensation and the body play in our phenomenology of perception, specially applied to architecture. Another important application could be the development of methods to facilitate the onset of these remarkable experiences. It is likely that aesthetic appreciation, especially of the exceptional kind, has a higher probability of success if we approach architecture with states of embodiment and emotionality similar to those found in this study. Our architectural training too often blinds us from recognizing that subjective conditions are (perhaps) as important as objective circumstances (e.g., the place ‘itself’) when dealing with aesthetics. We need two to tango.

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I want to thank the thousands of individuals worldwide who gave their time to participate in the survey. Not only is each selfless act helping advance the state-of-the-art of our knowledge but, more importantly, but also a living proof of the true and staying power and relevancy of architecture in our lives.

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APPENDIX I

Survey Questions gauging embodiment and emotion during EAEs. The 9 in bold letters were designed to directly gauge them whereas the other four bring supporting information.

Question 4: The arousal of the extraordinary experience was... Gradual, Sudden, Don't recall

Question 5: The arousal of the extraordinary experience was... Surprising, Expected, Don't recall

Question 9: As it was happening, did your extraordinary experience of architecture make you weep? Yes, No, Don't Recall

Question 10: As it was happening, did your extraordinary experience of architecture make your body react (e.g., trembling, goose bumps, shivers)? Yes, No, Don't Recall

Question 13 While it lasted, did your extraordinary experience of architecture feel stable? Yes, No, Don't Recall

Question 14: While it lasted, did your extraordinary experience of architecture feel intense? Yes, No, Don't Recall

Question 15: While it lasted, did your extraordinary experience of architecture feel profound? Yes, No, Don't Recall

Question 16: While it lasted, did your extraordinary experience of architecture feel vivid? Yes, No, Don't Recall

Question 17: Was your extraordinary experience of architecture spontaneous?

Question 18: Was your extraordinary experience of architecture controllable?

Question 19: Was your extraordinary experience of architecture ended at your will?

Question 22: How vivid and memorable was your extraordinary experience of architecture in comparison with other very strong life experiences? Well above, Just above, Similar, Just below, Well below

Question 28: How fresh/vivid is your recollection of this extraordinary experience today? Strong (feels like yesterday), Moderate, Vague

APPENDIX 2

CHART 1: P-values obtained through significance tests of the correlations among 13 variables gauging embodiment and emotion in EAEs. The existence of a correlation is established by a p-value <0.05 while no correlation by a p-value >0.05. Underlined numbers indicate 'borderline' p-values (0.07>p<0.05) that are likely (and therefore accepted) to point at a dependency between the variables. N varies from 1,286 to 1,116 (survey in English) and 584 to 376 (survey in Spanish) depending on the question/variable. Black cells show at least one of the p-values to be above 0.05 (and beyond borderline condition), that is, prove no significant correspondence between the variables. As in the rest of the paper, bold numbers stand for English survey statistics whereas italics for Spanish poll data.

	Sudden	Surprising	Weeping	Body Reactions	Stability	Intensity	Profundity	Vividness	Spontaneity	Controllability	Willful Ending	Comparison	Vivid Recall
Sudden		0.000 <i>0.000</i>	0.069 <i>0.024</i>	0.000 <i>0.053</i>	0.080 <i>0.215</i>	0.000 <i>0.025</i>	0.010 <i>0.057</i>	0.001 <i>0.180</i>	0.000 <i>0.000</i>	0.000 <i>0.031</i>	0.008 <i>0.085</i>	0.006 <i>0.059</i>	0.000 <i>0.000</i>
Surprising	0.000 <i>0.000</i>		0.025 <i>0.264</i>	0.002 <i>0.754</i>	0.455 <i>0.109</i>	0.012 <i>0.000</i>	0.000 <i>0.004</i>	0.002 <i>0.007</i>	0.000 <i>0.000</i>	0.000 <i>0.081</i>	0.002 <i>0.381</i>	0.000 <i>0.001</i>	0.000 <i>0.000</i>
Weeping	0.069 <i>0.024</i>	0.025 <i>0.264</i>		0.000 <i>0.000</i>	0.000 <i>0.008</i>	0.000 <i>0.003</i>	0.001 <i>0.028</i>	0.000 <i>0.001</i>	0.000 <i>0.094</i>	0.000 <i>0.000</i>	0.000 <i>0.614</i>	0.001 <i>0.008</i>	0.002 <i>0.070</i>
Body Reactions	0.000 <i>0.053</i>	0.002 <i>0.754</i>	0.000 <i>0.000</i>		0.000 <i>0.002</i>	0.000 <i>0.111</i>	0.002 <i>0.005</i>	0.021 <i>0.536</i>	0.000 <i>0.025</i>	0.000 <i>0.002</i>	0.000 <i>0.112</i>	0.000 <i>0.000</i>	0.000 <i>0.176</i>
Stability	0.080 <i>0.215</i>	0.455 <i>0.109</i>	0.000 <i>0.008</i>	0.000 <i>0.002</i>		0.000 <i>0.000</i>	0.000 <i>0.000</i>	0.000 <i>0.007</i>	0.002 <i>0.036</i>	0.000 <i>0.000</i>	0.000 <i>0.000</i>	0.175 <i>0.339</i>	0.051 <i>0.005</i>
Intensity	0.000 <i>0.025</i>	0.012 <i>0.000</i>	0.000 <i>0.003</i>	0.000 <i>0.111</i>	0.000 <i>0.000</i>		0.000 <i>0.000</i>	0.000 <i>0.000</i>	0.000 <i>0.056</i>	0.000 <i>0.409</i>	0.000 <i>0.002</i>	0.000 <i>0.028</i>	0.000 <i>0.000</i>
Profundity	0.010 <i>0.057</i>	0.000 <i>0.004</i>	0.001 <i>0.028</i>	0.002 <i>0.005</i>	0.000 <i>0.000</i>	0.000 <i>0.000</i>		0.000 <i>0.000</i>	0.004 <i>0.014</i>	0.193 <i>0.010</i>	0.001 <i>0.008</i>	0.000 <i>0.016</i>	0.000 <i>0.004</i>
Vividness	0.001 <i>0.180</i>	0.002 <i>0.007</i>	0.000 <i>0.001</i>	0.021 <i>0.536</i>	0.000 <i>0.007</i>	0.000 <i>0.000</i>	0.000 <i>0.000</i>		0.000 <i>0.002</i>	0.001 <i>0.120</i>	0.000 <i>0.380</i>	0.000 <i>0.633</i>	0.000 <i>0.000</i>
Spontaneity	0.000 <i>0.000</i>	0.000 <i>0.000</i>	0.000 <i>0.094</i>	0.000 <i>0.025</i>	0.002 <i>0.036</i>	0.000 <i>0.056</i>	0.004 <i>0.014</i>	0.004 <i>0.002</i>		0.000 <i>0.000</i>	0.000 <i>0.000</i>	0.000 <i>0.000</i>	0.000 <i>0.029</i>

Sliding scale: A case study in metric selection

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ABSTRACT:

A sustainable built environment will require significant innovations to the conventional mode of building design and delivery. Metrics-based rating systems by their nature steer a project development because of their narrowly bounded definition of “success”. However, the reductive nature of any single measurement or system constrains innovation, particularly the high-level re-thinking that will ultimately be required for the conceptual and technological leaps to achieve “true” or functional sustainability. This paper presents a case study of the challenges inherent in selecting and implementing an appropriate rating system for the design and delivery of an office park currently under construction near Amsterdam. It specifically looks at BREEAM, LEED-NC and GreenCalc+. This paper offers a brief discussion of what these three systems measure, and how each proved insufficient at capturing the innovation and high ambition of this project. It offers further discussion of why the team chose to define a unique set of metrics to benchmark the project over the course of its design and delivery. This paper attempts to succinctly problematize what is, in fact, a measurement challenge facing any piece of the built environment viewed over its lifetime of changes and adaptations.

CONFERENCE THEME: On Measurement

KEYWORDS: metrics, rating systems, LEED, BREEAM

INTRODUCTION

Sustainable architecture’s overarching goal is to provide a built environment which can be constructed, inhabited, and deconstructed in a dynamically stable relationship with the natural environment. Contemporary design and construction faces the challenge that the intersection of the built and natural environments is at times unstable or unsustainable at both local and global levels. This unsustainability manifests itself in various ways, from quantifiable impacts like resource scarcity, waste accumulation, natural habitat reduction, and human health risks to more subjective or qualitative impacts like diminished community, reduced access to natural areas, and disconnection from natural rhythms. Each of these manifestations has a host of quantitative and qualitative indicators, useful in determining improvement or worsening of these impacts. This paper contends that a truly sustainable built environment will require significant innovations to the conventional mode of building design and delivery; environmental impacts from the built environment will not disappear, but will be manageable by healthy ecosystems.

Within the last decade there has been growing clarity on the impacts the built environment has on the natural, and increasing momentum among designers (and others) to lessen or better manage this impact. However, lexical disagreements, principal-agency problems, and demonstrable causality challenges abound within the realm of sustainable design. Clearly something must be done, but exactly what are we aiming to achieve? Who is responsible to take action? How far must one stray from conventional practice to be sustainable? Many of these questions are outside the scope of this paper, but the struggle to answer these questions in order to formulate a sustainable mode of action forms the background to the discussion presented herein.

Ahead of clear answers to these potentially unanswerable questions, there have arisen a number of metrics-based rating systems intended to assess progress toward sustainability. Because these are designed to measure departure from convention, metrics-based rating systems are not obliged to articulate an end goal or target; there is no clear picture of what a, say, “LEED Platinum world” would be, or argument that this would be a sustainable one over time.

Through examination of a case study office park development in Holland, this paper attempts to articulate the challenge in selecting or developing a metrics-based rating system for a project of high ambition and prolonged build out, and attempts to show the limitations of using a temporally discrete rating system. The metrics-based ratings systems considered for this project were BREEAM NL, LEED NC, and GreenCalc+. The paper begins to suggest, through this example, a framework for a project-specific metrics-based approach for assessing and communicating movement toward a series of project-specific but high-level goals. The focus of this paper is on unpacking the selection of a rating system; it tries to understand what attitudes are embodied by these systems, whether they might constrain or enhance innovation, and how they might work to measure a project's improvement over time.

I. METRICS-BASED RATING SYSTEM LOGIC

As discussed above, definitions of sustainability of the built environment vary, and beyond semantic distinctions, there exist a plurality of logics illustrated by diverse concepts of sustainability (Guy and Farmer 2001); these manifest in differing images and approaches to sustainability from the natural to the cultural to the technological (Williamson, Radford, Bennetts 2003). The “technical image” of sustainability put forth by Williamson, Radford and Bennetts

forefronts hard ‘facts’, and particularly the ‘environmental facts’ of the constituents of air, lighting and noise levels, resource consumption, etc., along with equally measurable economics. Success can also be measured: reduced energy consumption, reduced embodied energy in materials, internal temperatures and lighting levels within desired levels, reduced initial and operating costs (Williamson, Radford, Bennetts 2003, 32).

Similarly, Guy and Farmer’s “Ecotechnic Logic” is

based on a technorational, policy-oriented discourse which represents a belief in incremental, technoeconomic change and that science and technology can provide the solutions to environmental problems (Guy and Farmer 2001 141-142).

The eco-technic logic is typified by the metrics-based rating systems of BREEAM, LEED, and GreenCalc+. Each system breaks the challenge of sustainability into categories (energy, water, materials, etc.), and sets up a system by which to measure a departure from a conventional approach according to a set of pre-determined metrics. These systems attempt to shed light on the many questions facing by building designers, questions echoed in those arising from their clients in the real estate market,

Measurement and assessment is at the forefront of the private sector commercial real estate industry today. As corporate boards, pension boards and other senior management have declared their commitment to looking closely at sustainable issues in their real estate, portfolio managers, corporate real estate executives, and facility and property managers are struggling to determine what level of sustainable performance they should strive for, how sustainable their properties are today, and what they need to do to better measure, monitor, and manage sustainability going forward. (Muldavin 2010, 26).

Metrics-based rating systems give the appearance of an answer to these questions. Indeed, this is the fundamental utility of metric based rating systems: they allow for clear definition of performance and objectivity in assessing outcomes. Requirements and thresholds vary among rating systems, as discussed briefly below, but the fundamental alignment remains the same: sustainability will be achieved, over time, through “incremental, technoeconomic change”.

Widespread adoption of increasingly stringent metrics-based rating systems would theoretically allow for accomplishment of specific quantifiable goals given enough time. However, the systems by their nature steer a project's development toward a narrowly bounded definition of “success” through specific technology application, or achievement of particular quantitative performance thresholds. The incentive in these systems is toward accomplishment of the credit target and no further – call it “micro-innovation”. High-performance beyond this – call it “macro-innovation” – is only mildly rewarded, regardless of how much closer one lands to the rating system's ostensible end goal.

While metrics-based rating systems are ill-suited to measuring ambition grounded in another logic of sustainability, such as the eco-aesthetic, eco-cultural, or eco-medical (Guy and Farmer 2001), they

serve the purpose of demonstrating cost-savings due to the resource conservation aspects of some sustainable strategies. Indeed, there has been a greater conflation of sustainability with cost-saving during the last years of economic recession. As construction and operational budgets have gotten tighter, quantitative and numerical impact assessments using easily understood and comparable metrics (e.g. tons of CO2 averted, gallons of water saved, kW of energy reduced) have increasingly been used to inform economic decisions about first and lifetime costs. The very second paragraph of the LEED Reference Guide for Green Building Design and Construction states

Green building practices can substantially reduce or eliminate negative environmental impacts through high-performance, market-leading design, construction, and operations practices. As an added benefit, green operations and management reduce operating costs, enhance building marketability, increase workers' productivity, and reduce potential liability resulting from indoor air quality problems (LEED Reference Guide 2009, xi).

Promising though the match between current rating system logic and market valuation may be, sustainability is not yet deeply integrated into investment decision-making, with decisions made largely through basic calculations of simple payback or return on investment. Muldavin points out that while progress has been made in this area,

Most investors, and many tenants, today understand that sustainable properties can generate health and productivity benefits, recruiting and retention advantages, and reduce risks, but struggle to integrate benefits beyond cost savings into their valuations and underwriting. The failure by property investors to appropriately incorporate revenue and risk considerations into sustainable investment decisions has led to underinvestment in sustainability (Muldavin 2010, 1)

The insufficiency of current metrics-based rating systems to measure these benefits creates an opportunity to provide a means to track these and other benefits of sustainable design.

2.ASSESSMENT AND INNOVATION ACROSS THREE METRIC-BASED RATING SYSTEMS

A rating system can be seen as a collection of reductive metrics; it has breadth compared to achievement of a single metric because of its multivalent nature, but still does not reward high-level rethinking or macro-innovation. Put another way, the challenge put forth by a rating system is to achieve a large number of mildly challenging targets, rather than overcome any single significant challenge. There is no incentive, through rating systems scoring, to achieve quickly the sort of sustainability that the rating system aims to provide in the long term – its incentive structure is in fact set up to provide *only* the incremental change that it is designed to measure.

It is important for this discussion to review the categories of assessment and mechanism to reward innovation in rating systems. In general, while metrics-based rating systems help to channel micro-innovation toward accomplishing a specific, finite task, the inherently reductive nature of metrics and the specific thresholds in place in rating systems can constrain macro-innovation and higher levels of performance.

	BREEAM-NL weighting	LEED-NC credits	GreenCalc
Management	12	8	GreenCalc+'s assessment mechanism is not checklist based, and cannot be compared using these point categories. It uses an LCA approach to assess <i>all</i> environmental impacts from energy use, water consumption, and material consumption over the lifetime of the building.
Health and Well Being	15	13	
Energy	19	28	
Transportation	8	17	
Water	6	10	
Materials	12.5	12	
Waste	7.5	2	
Land Use and Ecology	10	4	
Pollution	10	7	
Innovation / Regional	10	9	

Figure 1: Rating system credit allocations (BREEAM-NL 2010, LEED-NC 2009, and GreenCalc+ 4.0)

2.1 BREEAM

The UK's Building Research Establishment Environmental Assessment Method was created in 1990 and has certified over 115,000 buildings, and over 700,000 registered for certification (BREEAM-NL 2010). Eight versions of the rating system exist to accommodate different building typologies in various stages of construction and use.

BREEAM NL v 1.11 2010

A version of BREEAM designed for use in Holland was released in 2010. As with BREEAM's other systems, it groups sustainability issues into nine categories: Management, Health and Wellbeing, Energy, Transport, Water, Materials, Waste, Land Use and Ecology, and Pollution. Credit weightings for these categories are seen in Figure 1. The Innovation category offers points for techniques not covered in other credits and exemplary performance relative to credit thresholds. BREEAM-NL 2010 offers 11 credits out of 67 which can achieve an innovation credit for exemplary performance, each adding 1% score to the final building score to a maximum of 10% total. A 30% score is the minimum to achieve the lowest qualifying rating of "Pass".

2.2 LEED NC 3.0

The U.S. Green Building Council's Leadership in Energy and Environmental Design was created in 2000 and has certified 2,476 buildings, with over 10,000 registered (Green Building Facts 2009). Like its predecessor BREEAM, there are several typologically specific rating system versions. LEED NC groups 55 sustainability credits into five categories, plus one for Innovation in Design: Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, and Indoor Environmental Quality. For 45 credits, the rating system requires a project to meet a quantitative threshold. For example, Sustainable Sites Credit 7.2 assigns one point if a sufficient percentage of the roof is covered with reflective or vegetated material. For the other 10 credits, LEED rewards higher performance with more points. For example, Energy and Atmospheres Credit 2 assigns one point for offsetting 1% of annual energy costs with renewable energy, and 7 points for offsetting 13%.

The Innovation in Design category allows for up to five additional points for either innovating beyond the system's categories, or by exceeding one of the credit thresholds. Although this creates a mild reward for surpassing a point threshold, there is usually no reward for eclipsing it. LEED 2009 NC offers 17 credits out of 60 where an additional innovation point can be garnered for surpassing a credit threshold, though only three such points can be accrued, out of a total 110 points. A minimum of 40 points must be achieved for the lowest rating of "certified".

2.3 GREENCALC+4.0

GreenCalc is an assessment tool for office buildings developed in 1997 by the Dutch Institute for Building Biology and Ecology, and revised in 2005 and rereleased as GreenCalc+, currently in version 4.0. The wizard-drive program analyzes the total lifecycle environmental costs of emissions, resource consumption, land-use, and "nuisance" from a given construction, and expresses these environmental costs in Euros per year and per square meter (Van Keeken 2001). The index produced by the program gives the relationship between the new building and a normative building designed to typical convention in 1990. Included in the program's life cycle assessment are the building's modeled energy consumption, modeled water consumption, and all materials used in the building's construction. Improvement in any of the three categories beyond the 1990 baseline will increase a project's score, which has no prescribed upper limit. GreenCalc+, therefore, imbeds a score incentive toward exceptional performance relative to its metrics.

3.PRESSURE-STATE-RESPONSE FRAMEWORK AND LATENT ENVIRONMENTAL STATE CRITERIA IN RATING SYSTEMS

It is helpful to see metrics-based rating systems within the larger framework of action Albert Adriaanse developed in his work on indicators of environmental performance (Adriaanse 1993). This framework is used by, among others, the United Nations to monitor the increase in sustainable development (Van Keeken 2001). As discussed earlier, current rating systems exist to measure incremental change toward some quantitative goal; the framing of this goal is critically important to the rating system’s ultimate utility. Adriaanse points out that

The quality of a performance largely depends on the clearness and transparency of the targets formulated. Environmental performance indicators can be used as a tool to enlarge clearness and transparency of both the given situation and the target formulated. (Adriaanse, 1993)

In his terms, as shown in Figure 2, the metrics of a rating system would be a policy-based Environmental Response (Decisions – Actions) taken by Agents as a response to the Environmental State. If these are indeed to have the desired effect on the environmental state, selection of the metrics must be clearly linked to the state of the environment on which impact is desired.

Note also that any single goal or metric, even if framed in terms of environmental state, is merely one indicator of the overall state of the environment—necessary but not sufficient for sustainability. Similarly a human body temperature of 98.6°F is a necessary indicator of health, but is not sufficient to describe health if, say, one’s leg is broken.

It is worth reviewing the environmental state indicators which underlie the three rating systems examined herein. Note that these are not part of the active vocabulary of the systems, but provide the groundwork for the structure and orientation of the systems. Precise environmental state criteria are not articulated by rating system authors; this may have been considered outside the scope of the rating system’s creation. Thus it is still not clear what the criteria of the end goals would be beyond broad, open-ended definitions of sustainability.

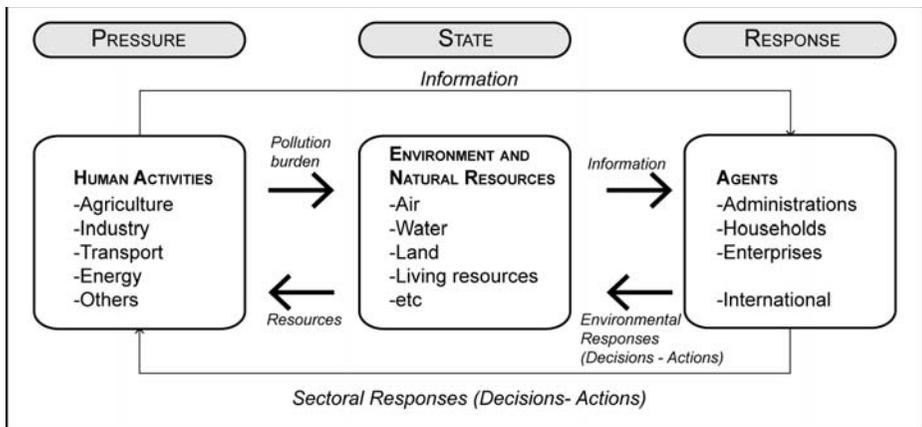


Figure 2: Pressure - State - Response Model Source: (Adriaanse, 1993)

3.1 BREEAM

According to the BREEAM literature, the first aim of BREEAM is “to mitigate the impacts of buildings on the environment”, with an objective of setting “criteria and standards surpassing those required by regulations, and challenge the market to provide innovative solutions that minimize the environmental impact of buildings” (BRE Standard 2009, 7). To qualify as an innovative solution, a strategy must impact one or more of the following issues (BRE Standard 2009, 35)

- Mineral resource depletion
- Fossil fuel depletion
- Acidification
- Climate change
- Nuclear Waste
- Stratospheric Ozone Depletion
- Eco-toxicity
- Eutrophication
- Human Toxicity
- Photochemical ozone creation
- Waste Disposal
- Water Use
- Deforestation
- Urban Sprawl
- Reduction of Biodiversity
- Noise and Nuisance
- Loss of Heritage
- Indoor comfort
- Health and Safety
- Access and Inclusion

Here the BREEAM system is articulating a mixed set of indicators of environmental state and human activity burdens. It sheds some light on the overarching intended goals of this system, while stopping short of providing criteria for these indicators. The system is designed to assess a building at one point in time, and does not attempt to aggregate the building's impacts across its lifetime.

3.2 LEED

The USGBC's literature is less direct in articulating what sorts of environmental impact the rating systems attempt to mitigate. The introduction to the 2009 rating system provides a series of statistics and anecdotes to emphasize the problems of conventional building:

The environmental impact of the building design, construction, and operations industry is enormous. Buildings annually consume more than 30% of the total energy and more than 60% of the electricity used in the United States. In 2006, the commercial building sector produced more than 1 billion metric tons of carbon dioxide, an increase of more than 30% over 1990 levels. Each day 5 billion gallons of potable water are used solely to flush toilets. A typical North American commercial building generates about 1.6 pounds of solid waste per employee per day in a building with 1,500 employees, that can amount to 300 tons of waste per year. Development alters land from natural, biologically diverse habitats to hardscape that is impervious and devoid of biodiversity. The far-reaching influence of the built environment necessitates action to reduce its impact (LEED BD&C Reference Guide 2009, xi).

It goes on to state that, "Green building practices can substantially reduce or eliminate negative environmental impacts through high-performance, market-leading design, construction, and operations practice" and cites many anecdotes of success.

From this it could be deduced that the primary LEED NC aims are to reduce total energy and electricity consumption, reduce CO₂ emissions, reduce potable water usage for sewage conveyance, reduce solid waste production, and support biodiversity. Like BREEAM, the LEED system is articulating a set of indicators of human activity burdens, while stopping short of precise criteria for these. Also similarly to BREEAM, the assessment occurs at one point in time, and does not account for activity over the building's lifetime.

In its category rewarding innovation, LEED NC requires that a project exceed the requirements of another LEED credit, or "demonstrate quantitative performance improvements for environmental benefit" (LEED BD&C Reference Guide 2009, 594). These improvements must be comprehensive and applicable to other projects. Nowhere within the reference guide is an articulation of what sorts of environmental benefits qualify, what the criteria for these benefits are, and whether these must, like the overarching LEED aims, be framed in terms of reduction of human activity burdens.

3.3 GREENCALC+

GreenCalc+'s LCA-based assessment system attempts to directly measure environmental impacts, at least for the basis of relative comparisons. Per the Twin2010 model of sustainability indicators, the following impacts are assessed (Environmental Construction Classification 2002, 3):

- Greenhouse effect
- Ozone degradation
- Human toxicity
- Aquatic toxicity
- Terrestrial toxicity
- Photochemical oxidant formation
- Acidification
- Eutrophication
- Biotic resource consumption
- Abiotic resource consumption
- Energy consumption
- Land use
- Nuisance due to smell
- Nuisance due to traffic noise
- Nuisance due to sound
- Nuisance due to light pollution
- Nuisance due to increased disaster risk

Here GreenCalc+ is, like BREEAM, listing a mixed set of indicators of both environmental state and human activity burdens. Unlike the previous two systems, however, GreenCalc+ assesses a project across its anticipated lifetime.

4. RATING SELECTION CASE STUDY: PROJECT INTRODUCTION

This paper cites a specific case study to highlight the specific challenges in selecting an appropriate rating system, and using such a system to assess high ambition over time. The project, on which the author worked as a sustainable design consultant, entails the design and construction of a 91600 m² (1,000,000ft²) office park near Schiphol Airport in Hoofddorp, the Netherlands. The phased build-out will take place over 10 years, and the aspirational client and designer intend the project to become increasingly sustainable as construction proceeds.

Research concurrent with design and construction is investigating building material health primarily, but also a number of other cutting edge building performance strategies. Not only would late-phase buildings accrue technical expertise in sustainable technologies from early-phase buildings, but as earlier buildings are maintained and refitted out they would incorporate the latest sustainable materials and strategies. Ideally each change would make the buildings more sustainable.

The national policy context is important to recognize; the Dutch government aims to reduce the environmental impact of all activities in order to achieve sustainable development in society within one generation. A series of national plans, including two covering building, were developed in the 90s, using the Brundtland-commission definition of sustainability as a starting point.¹ Plans for a sustainable built environment focus on the creation of impact assessment tools for various scales of development (van Keeken 2001). This context creates a public more conversant in and demanding of environmental assessment.

The assessment of materials for human and ecological health impacts was an important goal for this project. Here the Dutch building context provided a tremendous resource. Since 1993, the Netherlands Institute for Building-Biology and Environment (NIBE) has published a list of building materials and assemblies assessed using LCA for reference in design and construction decision making.² Building materials are classified based on their environmental impact across the lifecycle – from extraction and production, through a lifetime of use, to deconstruction and incineration or recycling. As with the LCA-based GreenCalc+ assessment tool, the criteria are energy consumption, resource depletion, land use impacts, emissions to air and water, health impacts, durability and reuse potential (van Keeken 2001). Each criterion is scored and weighted.³

4.1 PROJECT GOAL SETTING

Early in project conceptualization, and prior to selection of a rating system, the team set a number of high-level goals it intended to accomplish over the 10-year life of the office park's development. The team recognized that such goals were unreachable for construction of the first building, but as

the project's body of research developed, subsequent buildings would become smarter and more sustainable. (Also, as park-scale strategies for energy production, heat exchange, and waste water treatment came on-line, the early-phase buildings would also become increasingly sustainable.)

- **Eliminate all waste:** The project aims to keep materials used in the project in safe, closed loops from manufacture through use to re-use/re-manufacture. The ideal is for building components to be disassemblable such that renovation would allow for material separation, and recycling with a high level of material purity. Here it is important to measure the potential for these materials to be cycled safely, a property of both assemblies and components.
- **The project aims to provide the healthiest building materials available.** This entailed a research effort to build a body of knowledge from which to select materials most supportive of human and ecological health. The challenge here is to track both the better characterization of materials in a building, (even if no ideal materials existed) and the actual quality of materials selected.
- **Export Clean Energy:** An end goal of the project is to become a net energy exporter upon full build-out. Early phase buildings will be grid-connected, though low-energy consumers, and will at a later date be shifted to an onsite biofueled cogeneration source.
- **Create Healthy Spaces:** The project aims to create better connectivity to the natural environment than any other building in the area. The idea is to create good, occupiable spaces inside and out.
- **Create symbiosis:** Another project goal is to create good support of flora and fauna existing on the site before construction began, and to improve both habitat and biodiversity.
- **Achieve water balance:** The project intends to collect rainwater, recycle greywater, and treat all blackwater onsite. As with energy production, this capacity will arrive in phases, where buildings will initially be connected to conventional utilities, and later switch over to the onsite facility.

Many of these goals are built upon an understanding that the project will grow as it builds out, but also change over time. There is a need to show both how the project performs at a point in time, and where it was along a trajectory toward a larger end goal. How best to do this with a conventional rating system?

In the framework of the Pressure-State-Response model, the project's approach was to provide a "positive pressure" on the natural environment, rather than a pollution burden. The project established three goals framed in the terms of environmental state criteria (Ecological health and habitat, Human health and well being, and Connection between people and the outside environment) and two goals framed in terms of project activity pressure (Renewable energy production, and Onsite treatment of water).

As a means to these ends, the project team decided to track metrics for the following: Energy demand reduction

- On-site renewable production
- Off-site renewable purchases
- Potable water use reduction
- Water cleansing
- Balanced water use
- Materials quantity optimization
- Design for reutilization
- Material health
- Quality daylighting and views
- Fresh air and comfort
- Acoustic quality
- Habitat creation
- Connection to outdoors
- Community amenities

5. DISCUSSION

It is important to note that goal setting for this project was not driven by a definition of success per a rating system; rather, a system was sought which could best reflect the level of achievement the project desired. Following the project goal setting, the team examined several rating system, particularly the three discussed in this paper. A system was needed which 1) could adequately reflect when the team had gone beyond best-practice, and could reflect the increasing sustainability over time of both the office park as a whole, and of the individual buildings within it; and 2) could communicate these results to the public.

Ultimately, the team decided to pursue a three-pronged approach:

First, a GreenCalc+ assessment was selected for clarity of results within the Dutch real estate market, while acknowledging that this did not capture all of the project's achievement in qualitative areas. This assessment will be performed for each building, as well as the office park as a whole. Whereas in the US the LEED systems have in the last several years begun to have recognition and traction in the real estate market, the longer-standing GreenCalc has sufficient penetration to be expected of projects with sustainable intentions.

Second, a BREEAM-NL assessment is planned to be undertaken for at least the initial buildings on the project, in part as a demonstration project of the new Dutch version of this system.

Last, and perhaps most importantly, the team has developed its own matrix-based method for tracking site-specific sustainability on the project. For each of the five major goals of the project, the team articulated four levels of accomplishment: 1) conventional practice, 2) current best practice, 3) aspirational practice, and 4) end goal accomplishment. Rather than providing a single number score for the project's achievement at a point in time, a graphical "dashboard" provides a visual assessment of the current state of achievement, simultaneously evaluating all five goals rather than reducing assessment to a single number. It indicates where the project is performing well, and where further achievement is needed to achieve the ultimate goals.

As a part of this, the team developed a series of graphs to indicate the performance of the project relative to the ultimate goals, to emphasize the progress toward this end, rather than focusing on achievement of interim metrics. Here is where the team's third assessment approach differs most from convention: it articulates long-term goals at either local or global level, it maps progress toward these goals over time, and it maintains multiple dimensions of qualitative and quantitative evaluation, rather than collapsing into a single number.

Project construction began only recently, so the test of this system's long term utility admittedly is yet to come. Given the project owner's interest in measuring and demonstrating unique improvement over time, this project is a good first test candidate. These mappings are not yet developed as a system

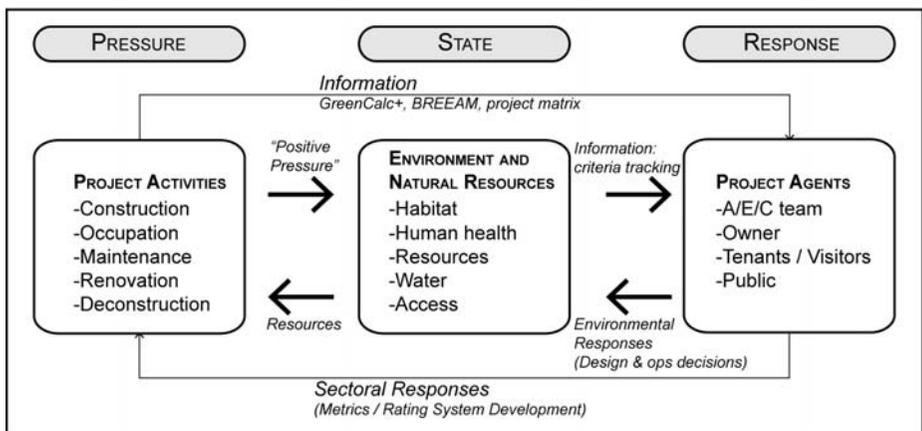


Figure 3: PSR Model for Case Study Project (based on Adriaanse, 1993)

to be universally applied, but are discussed here as an approach to assessment that may be undertaken in future projects intending to achieve radical sustainability. This may not yet translate readily to a US commercial market only beginning to understand a scorecard-based definition of sustainability. Ahead of any widespread adoption, this methodology may next prove useful to large institutional land-owners interested in long-term sustainability of their portfolios.

CONCLUSION

Briefly unpacking the discussions from the initial design phases of this project are illustrative for highlighting the latent properties of metrics-based rating systems.

First, it is evident that these systems proceed from a logic which assumes that sustainability will be achieved through incremental, quantifiable achievement. While serving a clear utility in communication within the economic market (often a non-technical audience) non-critical adherence to rating system logic is limiting in the ability to leap beyond this incremental change to achieve fundamental change. Ironically, these systems may also inhibit a single project's ability to incrementally improve itself over time.

Second, it is important for the end goal toward which the rating system is attempting to steer the built environment to be articulated. This will force deeper consideration of the alignment of indicators and criteria of both human activity pressures and the desired environmental state. Barring this, innovation is further constrained because other causal links may not be rewarded by the system.

Third, an area in which metrics-based rating systems are found to be weak is in the assessment of a project over time. Rating systems measuring building operations (such as LEED Existing Buildings Operations and Maintenance, or BREEAM In-Use) fill a void in the rating system continuum by addressing existing stock, the overwhelming majority of buildings. In theory these "longer snapshots" of performance could measure long term incremental achievement if buildings were continually evaluated. In practice this has not been undertaken. Beyond the implementation question, it is still problematic that the benchmarks against which projects are measured are defined generically, not by the building's own previous performance, hence mainly driving performance improvement by rating system requirements. Also, these rating systems manifest the second property described above, and do not articulate an end goal toward which existing buildings are ostensibly striving.

In conclusion, the professional building community is increasingly migrating toward an environment in which the discourse on sustainability surrounds metrics, and demonstrations of incremental improvement. It is essential that we retain an open dialogue about the higher-level goals toward which we are ostensibly moving our built environment. We must continue to assess our metrics to ensure that these are, in fact, moving us down the path toward these goals. Where quantitative metrics and rating systems do not capture our end goals, it is imperative that we continue to strive to fold subjective goals into a project's assessment.

It is critical that we do not become dependent on rating systems to define sustainability for us, given that many logics and images inherent in this aim cannot be fit into a system, no matter how large and diverse the collection of metrics. Mechanisms are needed to ensure innovation is rewarded outside the framework of rating systems, given the limited opportunities for innovation from within. Finally, rating systems must relentlessly become ever more aspirational if they are to achieve their own latent goals.

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ENDNOTES

¹The oft-cited Brundtland definition of sustainable development: "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

²The NIBE assessment uses the TWIN model for its LCA calculations.

³Weighting of criteria uses a methodology developed in 1989 for the Indicative List of Building Materials. This list creates one summary score equal to (4 * energy) + (4 * depletion) + (6 * damage) + (8 * emissions) + (8 * health) + (2 * durability) + (6 * reuse / recycling).

Urban heritage in action in the historic city of Fez: guest houses rehabilitation models

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ABSTRACT:

In the urban agglomerate of Fez, the old medina is distinguished by its extended and vital historical space. Despite a long process of deterioration, the urban heritage of the old medina has conserved its authenticity especially in the historical part that hosts an array of touristic projects. Funded by the World Bank, an integrated project has been set off in order to end the isolation of this part of the city. The present article is an attempt to contribute to the goal of characterizing the problem related to urban heritage rehabilitation in the historical part of the city of Fez. We discuss and diagnose the process of activating the rehabilitation of urban heritage by studying the initiatives related to the construction of guest houses, which are traditional hotels that vary in terms of luxury. In this work, we consider that urban projects constitute an interactive and multidimensional result of the rehabilitation process and the built urban heritage practices within a supposed relationship with the neighboring environment i.e. what is locally referred to as the alley or “derb”. In this context, we try to detect the different compatibilities between private investors’ initiatives and general public orientations. We expect that a deep analysis will either confirm or refute our main hypothesis in which we assume that there is a possibility of restructuring the internal fabric of “urbanization” in the historic medina. At the level of methodology, we adopt a qualitative approach based on extensive fieldwork in order to respond to the elements of the problematic, taking into account the complex and multidimensional character of the subject and its scientific projection. At the level of the general results of the study, the analysis of the representation and practices of urban heritage projects stresses the valorization of the process of significant positive practices.

CONFERENCE THEME: “On Measurement; Social environment”.

KEYWORDS: Rehabilitation Plan of the built heritage; historic Fez; development of local tourism; the process of guest house creation; profile type models.

INTRODUCTION

The old medina of Fez, the spiritual, scientific and cultural capital of Morocco, has been listed by UNESCO as a world heritage site since 1980. It is considered as one of the largest historical cities in the Arab and Islamic world: it is distinguished by its extended and vital historical space (El Bouaachi 2009), especially at the level of the economic dynamics and the high urban value (Fejjal 1993). Despite the degradation process, the urban heritage of the old medina still conserve its originality and authenticity, especially in the historic part (PNUD 1991) where many touristic projects are concentrated and where our fieldwork is carried out.¹

As a major result to participative planning and a series of public consultations, the major local stakeholders (institutional agents) agreed on an integrated project, for the historic city of fez. The study /project, “The Safeguard and Rehabilitation Plan” is funded by the World Bank, the purpose of which is to overcome the problem of isolation from which the historic city suffers by improving the traffic and access by means of designing special touristic routes to diversify the supply and extend the average stay of a visitor. (UNESCO 2004).

The institutional approach to public intervention in the urban heritage has been based on several studies financed by international organizations, especially the UNESCO and the WORLD BANK. The preliminary official conception adheres to a gradation logic, as it ranges from a regular, comprehensive and systemic approach to consensus building, leading to an integrated program. This includes multiple interrelated sub-projects according to the United Nations Program for Development

(PNUD, Ministère de l'Intérieur, 1991). This approach also required an appropriate legal framework including defining the role of "The Agency for the Reduction of Density and the Safeguard of the Old Medina of Fez" (ADER)² in taking charge of coordination, technical supervision and institutional control of the project (UNESCO 1991). The official studies have witnessed a significant progress in conception, through the social evaluation of the requalification process ((Royaume du Maroc, B.M. 1995). The study is based on a basic challenge represented in inverting the prospects of analysis and approaches used in former projects, with an emphasis on the transition from negative idealism to a positive one. Considering this fact makes it possible to emphasize the proposal raised in the project, a one that advocates the idea of supporting the rehabilitation of traditional houses (Royaume du Maroc, B.M. 1995).

This research aims at discussing the problems related to urban private rehabilitation of this historic core of Fez. Specifically, we attempt to identify and diagnose the process of activating the projects in relation to urban rehabilitation and renewal. The logic behind two pivotal operations, namely conception and execution shall be identified by studying the dynamics of the creation of guest houses. Those are traditional hotels that vary in terms of luxury. This research also aspires to discuss and diagnose the impact of these projects on the community and the space around them. Our fieldwork, questions the actual patterns of renewal, examining the material and social aspects of the process of construction and the practice of urban rehabilitation, that is based on the representative model of guest houses. Indeed, we consider that these urban projects adopt an interactive and multidimensional process of conception and practice, through a supposed relationship with the immediate environment of these projects, namely the local concept of the alley or "Derb". Our hypothesis consists of considering the increasing presence of a noticeable number of diversified groups that create guest houses within a framework of projects that aim at rehabilitating urban heritage according to different investment patterns, intervention time and size, and the logic that underlies it. The process of guest house creation, on another level, is supposed to lead to changes and transformations in the nature of linkage with the immediate environment of the surrounding neighbourhood.³

The first part of this work diagnoses the genesis and the process of extensive practices developed by private investors in the domain of guest houses' creation. The rationale behind this classification is to identify the elements that grant the heritage component an added value; this is accomplished by preliminary field observations that necessitate a consideration of the process of implementation of the projects in selected sites of the medina. The second part discusses the patterns of the rehabilitation practices via models reflecting guest houses projects' diversity, and considers the isolation of projects' from their local environment. (El Bouaaiichi 2008).

A preliminary analysis of the subject may not suggest the existence of a convergence or a divergence of the two processes of urban heritage practice neither the top-down approach, that is associated with private investors from outside the alley, nor the down-top one that comes from inside the local environment and which is practiced by the local population. It is expected that a deep analysis shall confirm the pivotal premise around which the present work revolves, namely that of the interaction processes of urban heritage and reuse that carries an economic and touristic value and that of the process of reuse of ordinary urban heritage that carries a dwelling value and which positively responds to the concept of "shared urban heritage", which has been recently advertized internationally within the general framework of sustained development (UNESCO 2004).

In this context, we adopt the new approach, one that is innovative and constructive as it seeks to depict urban heritage as a distinguished "identity" in the international market (El Bouaaiichi 2008). In this approach, it is expected that the local population will be involved in forming this entity and identity, in addition to private and public agents in a way that guarantees the projects' success and integration within their local environment (Navez-Bouchanine 2000). On this basis, the methodological procedure of this work adopts qualitative approaches, within the field of applied, urban and innovative geography that integrates territory science (Lévy & Lussault 2003), which are susceptible to effective geographical application⁴ (El Bouaaiichi 2004, Bailly 1995, Lévy 1994). Basically, this methodological procedure relies on diverse, extensive, complementary, and thorough fieldwork, which was carried out since 2001⁵ to assess the process of rehabilitation in action. The

data collection is based on semi-directed interviews. It should be noted that the interview by itself does not lead to a reproduction of stereotyped interview situations; in fact, this is an in-depth technique that reproduces real situations with all their complexities and multi-facets, a fact that makes it compatible with the subject under investigation. Two different groups have been targeted in this fieldwork, a thing that compelled us to devise two interview guidelines: an interview guide directed towards investors in guest house projects⁶, and another interview guide directed towards the local population.⁷ This population lives in the same semi-closed space i.e. the alley where projects are localized. In order to restrict the representative samples of the target population in both segments, all cases have been covered by means of filling a quantitative questionnaire that includes preliminary information that guarantees the identification of all relevant cases. In terms of content, the investors' interview guide contains four main axes,⁸ whereas the local population's one contains five axes.⁹

All in all, the objective of this fieldwork is to come out with exact, detailed, and qualitative conclusions that may either confirm or deny the considerable presence of positive mechanisms. These are expected to lead to a reduction of negative impacts. This may make it possible for guest houses and urban heritage in general, to reach social integration and an eventual real involvement in the dynamics of the process of sustainable development in a globalized world (Osmont 1997).

I. THE GENESIS AND THE PROCESS OF PRIVATE INITIATIVES

ADER has designed an integrated plan, with consensus of the local and institutional agents concerned. Both the state and the urban community of Fez will contribute to this plan, but the bulk of the funding depends on a loan from the World Bank under the auspices of UNESCO. This is a complex development project, including the activation of the component of "rehabilitation support" that aims to involve the low-income population in the effort of conserving traditional buildings (UNESCO 2004).¹⁰ The scheme also aims to develop the cultural and touristic potential of the historic city. Within the process of organizing and framing private investors' initiatives that accompany the public project of rehabilitation, the competent government authorities have issued a *dhahir* "decree" of the following: "the guest house, a touristic institution that accommodates tourists and provide services, should minimally consist of five rooms in order to be classified at least in the second category". The law defines two types of guest houses: first class and second class. Each type has a special criteria and characteristics that match the rank assigned to each guest house. Thus, it is clear that the classification criteria for the first category are based on geographical and security parameters as these houses are mainly located in periphery sites¹¹.

These house types known as *riads* are considered together with traditional houses, as the most prevalent types in the old *medina*. The *riad* refers to a house that has a garden inside. Now, the growing number of guest houses in the *medina* since 1997 constitutes a promising and unprecedented phenomenon as they were not to exceed in their early period before 2000 four guest houses, scattered along the western part of the historic city from north to south. The number increased from the beginning of this process and has reached sixty authorized and classified guest houses. This number is confirmed by the regional office of tourism. The actual number of this product may be a hundred, most of which are not authorized, and are used for purely touristic purposes whereas others are still under construction.

I.1. THE EMERGENCE OF THE FIRST GUEST HOUSES: A REFERENCE IN VALUING THE QUALITY OF AUTHENTIC URBAN HERITAGE

The initial dynamics of guest house creation were initiated in the historic city between 1997 and 1999 by investors in touristic development, who focused on providing commercial activities related to tourism, like handicraft and touristic animation. This being said, the associated dynamics are activated thanks to the first agent on the list, who is one of the most experienced professionals in the field of tourism. He relies on his prior experience as a former official in Marrakech, a city which was the first to transform traditional *riads* into guest houses in old cities. In this context, the *Fassi* model of guest house creation is characterized by local *Fassi* investments compared with Marrakech, a city characterized by foreign influence. (Wilbaux, Q. 2001).

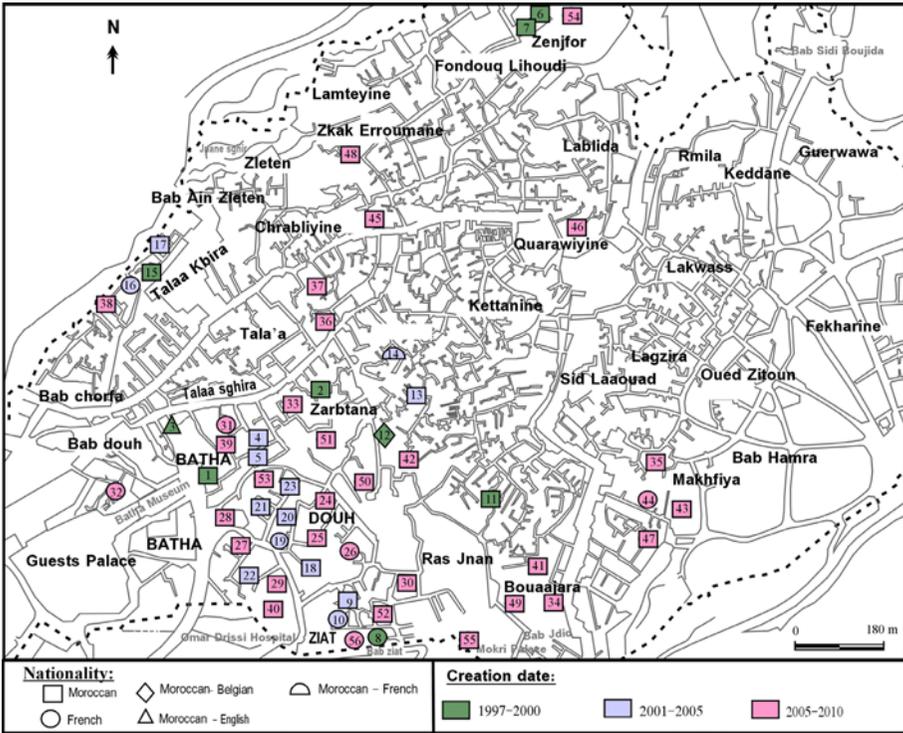


Figure 1: The distribution of guest houses according to the nationality of investors and the creation date of the project

The category of early investors also includes a minority of people with mixed marriages –Moroccan-French or Moroccan- Belgian- and who are strongly attached to owning houses in the historic city. The Fassi husband, who after a long period of immigration, returns back with his foreign wife to his city. He invests and lives in the historic medina. This first category invests in medium size projects that respond to the logic of their marriages and by translating this strong link with the historic city into an acquisition and rehabilitation of medium-sized traditional houses. This group of investors select relatively internal and less accessible sites (relatively far from parking places) for social reasons, like their attachment to some familiar alleys or where there is a concentration of their family members and acquaintances’ network. Whatever the size of the investment and its geographical location, it has become an engineering and urban reference for subsequent investments, at later stages. This reference is at the level of field testing of the rehabilitation techniques on the ground, on the one hand, and at the level of the evaluation of artisans’ skills in traditional construction and restoration on the other hand.

1.2. STAGE OF CREATIVITY: THE EMERGENCE OF LUXURIOUS “GUEST PALACES”

Since 2000, a new professional group entered the scene to contribute effectively to this experience; this group is dominated by architects who manage this creative an phase in the process of implementing projects on the ground. The huge investment allocated aims at activating these costly projects where “Dar Shahrzad” tops the list¹². This distinguished professional category employs all its creative skills to produce very large and luxurious guest houses, similar to ancient Andalusian palaces with easy access. In addition to the technical’ reproduction of the architectural’ fine details, the architects/ investors make these palaces more luxurious by the special beauty added to some of their parts like royal suites with highly decorated domes and handmade embroidered furniture, and ornaments

like antiquities and chandeliers. The creativity of architects reaches its climax when reconciling architectural authenticity and modern functionalism. At the level of other services and activities, these also reflect a kind of high creativity such as developing Moroccan cuisine by introducing new ways of presentation and innovative recipes that impress participants in cultural events and organized festivals .

1.3. THE DIVERSITY OF THE RANGE OF GUEST HOUSES IN THE TRANSITIONAL PHASE: INFLATION OF THE SOUTH WEST MARGIN

Since 2005, the market has witnessed an unprecedented excess in opening small to medium-sized guest houses, orbiting around the first guest house “*Riad La Maison Bleue*”¹³. It was inaugurated within the first process and initial phase in which “*Dar Shabrazad*” constitutes the top of the list, in terms of creativity and luxury. The rationale behind the proliferation of these guest houses around the two poles is manifested in the localizing of the two poles in the *medina* and which is clearly visible in all aspects of the rehabilitation of the alley, including the amelioration of the environmental, physical and security framework. These positive standards have guaranteed to the newly created houses the status of a second class category, if not a first class one, within the first leading houses in the domain. These houses try to distinguish themselves from the other poles through the provision of a variety of supplies in terms of prices and in terms of the recreational and cultural suggested activities. The basis of which is the attempt to create a bond between the tourist and the local environment.

1.4. QUALITATIVE DEVELOPMENT: VALUATION OF THE SOUTHERN MARGIN PRIOR TO THE FORMATION OF TOURISTIC COMPLEXES

Aspects of a qualitative evolution in the process of guest house creation started to appear in the observed changes in the logic of management and in the geographical settlements that head toward the south more than towards the west. This has to do with a qualitative change toward new future horizons that are bi-dimensional: the first dimension is represented by the new model that is based on the logic of innovative investment which is expected to lead to specialization in the future by changing the function of the institution from a guest house to a huge restaurant. The second is represented by an upcoming model, still underway, which is similar, as suggested by the initial signs observed in the field, to huge touristic complexes. As originally conceived, the project is based on the idea of constructing and linking five guest houses together to accomplish the largest traditional touristic structure that has the form of touristic complexes, but in an original way. Located at the top of the highest strategic site in the south of the historic city, these structures lead to an appraisal of the upper part of the *medina* by building luxurious cafés and restaurant from which you can see all the *medina*.

2. PATTERNS OF THE ACTIVATION OF REHABILITATION PRACTICES VIA MODELS REFLECTING GUEST HOUSES PROJECTS' DIVERSITY

A number of distinct and diverse profile types or representative models of rehabilitation have been collected and set with patterns of openness to/and interaction with the neighboring physical and social space. The aim is to measure and evaluate the act in its relation to the locus of intervention, namely the alley. In this context, we note that the qualitative data related to the particular elite of early investors was collected from the field according to the alley and/or the neighborhood. This allowed to feed to a large extent the process of building and of installing these profile types. Thanks to these early investors, the foundations and the logic of these initiatives within the framework of the revival of the old city was established. . The data investigated takes into account, and in a complex way, the perception, attitudes and the elements of satisfaction and dissatisfaction of the agents and the interviewed population that live in the alleys subjected to these dynamics. The intersection of these two types of qualitative data allows to draw six “profile types” in the qualification of these projects, on the basis of the presence of some of the variables within the same “profile type” and which is related, in a way or in another, to the type, form and nature of the relationship with the neighboring space as we have relied on these variables to collect representative cases in each profile type.

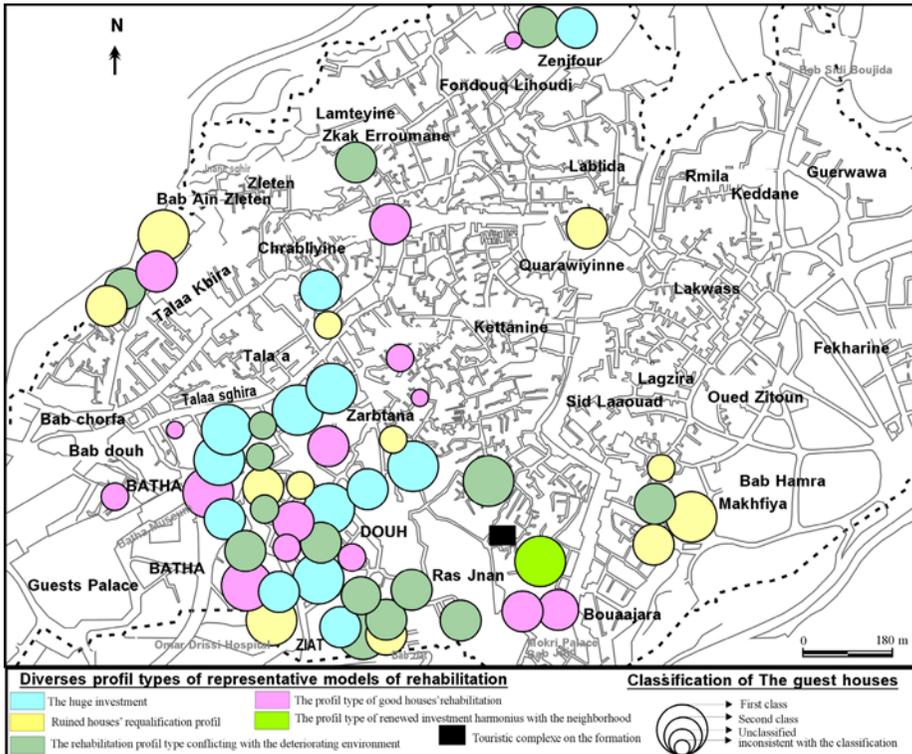


Figure 2: Localization of guest houses according to the type profile of the rehabilitation and the official classification

2.1. THE HUGE INVESTMENT PROFILE TYPE CONCURRENT WITH THE PRESSURE OF THE NEIGHBORHOOD

A huge amount of money has been allocated to give priority to the rehabilitation of the sewerage network, which drains a lot of money from this investment. This profile type is also characterized by a strong mobilization in favor of the creativity and knowledge in the field of urbanism. In this profile, the issue has to do with a number of architects who have opted for the acquisition of a type of *riad* called “Big *riad*”, which has a unique access quality and which constitutes of a group of relatively deteriorated houses that require expensive rehabilitation, especially the one concerning infrastructure. In this context, the analysis confirms the link between this profile type and the tension at the level of the neighboring environment because of the effects of the heavy and bi-dimensional intervention such as the extended time of work, accompanied with environmental and auditory pollution in the alley, during the activation of rehabilitation work. In this regard, we can distinguish between two cases that are expressive and relatively different in so far as the relationship with the adjacent area is concerned and thus in terms of the pattern of negotiation or consensus adopted in the “alley” subject to this profile in its rehabilitation.

2.1.1. A willingness to be open to the adjacent space

This case is represented by a distinguished investor “the architect”, who owns the project which tries to recreate the traditional architectural model, open to the neighborhood unit in the historic city. The diagnosis and monitoring of this distinguished model is done through the specificity of the discourse and practices translated by architects/investors’ strong awareness and sensitivity towards the immediate environment of their projects, namely the alley. This is reflected, on the one hand, in the mobilization of engineering skills in the context of the special projects’ category of agents. On the

other hand, this is represented in the provision of technical expertise and supervision required for all the projects of the rehabilitation of traditional houses in the same “alley”.

In addition, the maintenance and management of the alley are considered as top priorities for this category of investors. In this context, the local population maintains two patterns in this act that have a strong social impact: the maintenance of the exterior facade of the alley, and the elimination of sources of pollution in places called locally “black spots” of the alley and which are deserted houses. At the level of communication patterns adopted, this expressive case is characterized by the ability to act, to react and to find points of agreement and consensus. It needs to be emphasized that the presence of NGOs in some neighborhoods facilitates negotiation processes.

2.1.2.A restricted relationship with the adjacent area

The limited character of the relationship finds its roots in the negative perception of the social neighborhood, and the absence of one negotiator, further deepens this negative perception. The “architect” sees that the adjacent territory as a source of blackmailing for traditional house owners who live next to guest houses. The discourse is bounded by a variety of requests for assistance by the neighbors and by demands to take charge of all forms of degradation caused to the houses near the projects concerned. The rejection of these demands is based on the investor conviction: that there is no “technical legitimacy”, the deterioration precedes the project and bears no relation with the latter.

2.2. RUINED HOUSES’ AND REHABILITATION PROFILE WITH A POSITIVE IMPACT

This type is based on the confluence of two positive factors: the importance of both material investment and social impact due to the broad and unconditional engagement of the local population in these projects. This rehabilitation profile adopts the strategy of restoring the original referential model through recreating the *riad* with all its details. The agent here falls within the category of the professional investor who has a significant number of guest house projects, ranging from two to three guest houses of the first category and a fourth in the process of achievement. This profile inaugurates a new process engendered in the activation of the heirs of collapse- threatened houses of the dynamics of taking in charge and restoring these houses. A distinction is made in this profile between two revealing and relatively different cases, at the level of the development of the relationship with the local social environment.

2.2.1.A positive development in the relationship with the adjacent area

The strategic location of guest houses at the entrance of the alley is the factor behind the positive evolution of the relationship with the nearby territory, by taking into account its double status as a “semi-private” space. This strategic localization makes it possible for the traditional houses in the alley to benefit from rehabilitation programs implemented by investors for the project concerning *riads’* restoration as guest houses. Guest houses substitute the deserted houses and rehabilitation operations spread over the entire alley. This is a simple operation with a visible and positive impact on the daily living patterns, thanks to its contribution in improving the living standards.

2.2.2. Relatively negative development in the relationship with the adjacent space

The location of deserted houses near guest houses is sometimes a source of social tension in the alley, where the desire to rehabilitate them by investors contradicts with the special value of these ruined houses which have a special place in the hearts of the local population, as they used to constitute religious places (known as a *zawiyas*) where Koran used to be read, mysticism used to be celebrated, and alms used to be given to the needy. In this way, the intervention becomes bounded by this religious symbolism which reduces the margin of freedom and restricts the operation and the maintenance of the houses.

2.3. THE REHABILITATION PROFILE TYPE CONFLICTING WITH THE DETERIORATING ENVIRONMENT

In this profile, the issue concerns the agent/investor who prefers to seize the opportunity to purchase cheap real estate at the expense of the inappropriate environment by focusing on the quality/price equation. These medium-sized and relatively maintained houses are located in relatively easy accessed but deteriorated alleys. Within this profile type, two revealing cases are distinguished according to the degree of social pressure against the nature of the investment, incompatible with the degraded place.

2.3.1. A social tension underway in the nearby area

In principle setting a guest house in one of the long and degraded alleys of the historic city like “Derb Elmiter” does not constitute any social problem. Despite its existence on the way that leads to the guest house, a formerly abandoned house would not create any environmental problem; however, the addition of a high roof to the guest house has worsened the whole situation in the entire alley as the local population sees that the subsequent building of an open roof at the top of the guest house, which stands over neighboring traditional houses, is the reason behind the worsening of this social crisis. From their viewpoint this intervention is an attack on the sanctity of the community (tourists’ taking panoramic photographs). This attitude has negated all forms of negotiations, a thing that led the population to adopt an offensive reaction, manifested in re-employing the ruined house as a locus of household garbage.

2.3.2. A relative mitigation of social tension

The issue we are concerned with is where the alley could reveal a strong social tension caused by an advanced physical deterioration of this space, which usually is simultaneous with the presence of polluting activities and open channels of liquid cleansing. In such cases, the social demands are quickly satisfied, for instance the investors’ accept to move the guest house air conditioners from the facade across the alley to the roof. Generally, the investor becomes reserved against the population, which is an attitude called in morocco “*tiqar*”.

2.4. THE PROFILETYPE OF SELECTING GOOD CONDITIONS OF HOUSES’ FOR REUSE

The strategy adopted by investors in this model is based on the principle of reducing investment costs, while ensuring the extension of the profits. This is about merging a new set of varied opportunities together, to acquire the best assortment, such as the acquisition of non-deteriorated houses that are located in previously rehabilitated areas by virtue of their hosting of the first wave of the equipped and well managed guest houses. Generally, this ideal assortment is directly associated with sites that are characterized by coexistence and where social tension has melted away. In this context, two revealing cases were detected in this profile, according to the quality and nature of the opportunities exploited.

2.4.1. Seizing the family opportunity

This is about re-owning the traditional “family house” which is in a good state and which is valorized by doing light, but aesthetic requalification operations. To grant the project an added value, the guest house relies on the advantages and the constituents of its strategic location such as its nearness to the administrative compound of the historic city, and its openness on one of the main squares that are highly dynamic at the level of connectivity to transportation means and at the level of the vitality of economic and touristic activities, located in the square (the *Batha* square). The quality of the neighborhood increases the advantages as it is the case with this revealing case where the neighborhood acquires the characteristic of warmth and mutual respect. In addition to this, this sample constitutes a strong impetus to similar new dynamics in the same alley that may eventually lead to the creation of other guest houses.

2.4.2. Seizing the chance of juxtaposition with similar projects

In this revealing case, we are concerned with the benefits drawn from a number of rehabilitation operations of the neighboring space. Therefore the valuation of the positive image is spread by the first guest house project in the alley on the basis that this positive image will be extended to the entire neighborhood, in the framework of what we call in the field of rehabilitation “the oil spot extension”. In this sample, these guest houses are distinguished as they supply various touristic formulas, varied in terms of quality and products and adapted to the urban particularities of the ancient fabric. We can cite the distinguished guest houses of the south-west of the historic city as a representative case that reflect the aforementioned dynamics.

2.5. THE PROFILE TYPE OF RENEWED INVESTMENT, HARMONIOUS WITH THE NEIGHBORHOOD

This profile type is considered as a new and outstanding orientation at many levels. It is driven by a new and a different logic where the “agent/investor” is an experienced professional, who owns a travel agency and uses his experience and his professional network to seize real estate opportunities, at the right time and in the right place amid the great number of projects. Despite the temporary acquisition of a real estate, the final decision of choosing the new place, south of the historic city took a year of consultation and evaluation as a whole. This evaluation is based on the logic of the outstanding investor who programs his pension at a later period, a thing that pushes him to split the huge investment into regular payments according to this medium term. This logic allowed him to have a margin of freedom that made it possible for him to:

- Expand the size of the project and be flexible in the diversification of its functions: on the one hand through the acquisition of the first small house and the valuation of the guest house project by acquiring the medium-size space house next to it after years of waiting and in search for opportunities; and on the other hand, through the activation and expanding to a specialized and professional Moroccan restaurant by utilizing and building two floors in the garden of the second house to host this new function. Behind this orientation lies the will of the investor, after retirement, to readapt the guest house to occupy its future new function, namely a huge restaurant compound that may accommodate from 200 to 300 people as the investor is convinced that the demand for this sort of services is increasing by virtue of the number of different and varied festivals that take place in the historic city throughout the whole year.

- Extend the time and improve the quality of “restoration” work by mobilizing three architects for three full years. The project investor considers this as an open laboratory to implement a successful “restoration” operation, from his own perspective. The private investor finalizes his conception of successful restoration by bringing craftsmen who are specialized in building traditional houses (*maalmiin*), mobilizing his relations’ network in the heart of the historic city.

In this way, this renewed investment and flexible practices have become distinct and positively integrated with its local environment. This is also reflected through the activation and coordination of the investor’s initiatives to ensure the maintenance, cleanliness and restoration of the exterior facades of the alley, along the lines of the traditional model used in the guest house Night guarding for the entire alley has been also ensured. As a result of this good alley management, and in a short time that did not exceed a year after the official inauguration of the guest house, the latter has become a positive element that helps in promoting the dynamics of medium and small guest house creation in the same alley, where others have become active and more are still under construction.

CONCLUSION

The outcome and the results of field work, at the level of the “qualitative models” of rehabilitation in parallel to the degree of the projects’ integration into their local environment, stress the valuation of the process of positive practices present. It allows to reduce and even overcome the impact of negative projects, which are fewer and less representative.

The growing number of guest house projects in the historic city of Fez is a relatively recent phenomenon. It includes positive mechanisms. The intersection of these private initiatives with the general public orientation for the safeguard is reflected at the level of three major components:

- First, at the level of the contribution of these projects to the rehabilitation of historical houses that has a distinguished urban value. It allows on the one hand, the attraction of tourist investments that range from medium to very large ones and the diversification of the cultural tourist product, in addition to the quality valuation and extended stay in Fez in general, on the other hand.
- Second, at the level of guest houses' contribution in improving traffic mobility and access to the "alley". This may be seen as an actual outcome of private management that takes charge of local issues of certain spatial units of the public domain i.e. the alley, where projects take place.
- Third, at the level of private investors' taking charge of the about-to-collapse traditional houses' rehabilitation: This concerns places that pose a significant threat as they cause an increasing territorial deterioration of the entire alley. This intervention by the owners of "guest houses" ensure a kind of social legitimacy, in relation to the act and local affairs of the alley.

Geographically, the results of the work confirm that the largest concentration of projects of guest houses responds to the forces of polarization exerted by the south-western outskirts of the historic city, thanks to their privileged location. Those parts of the historic city are open margins on the outside of the urban system, by means of transportation compared with the central original nucleus which is denser and "besieged". The urban specifications adopted in the selection of first class guest houses contribute to the valuation of these classy margins of the historic city.

At the level of "building" and installing "qualitative models" of rehabilitated guest houses, the results of the analysis show a positive outcome of three major orientations in the context of consensual management:

- A real willingness to take charge of private functions and management of the semi-public domains; the desire driven by the dominating urban "Fassi" origin of investors explains the re-acquisition of houses and the strong attachment to those "alleys", where projects of guest houses were adopted.
- The presence and relative awareness of the public interest; this remains linked to a stronger representation of civil societies, which still lack organization, support and adequate funding.
- A relative presence of openness and communication against a rise in social demands, especially at the level of activating the capacity to negotiate and search for points of consensus among investors and the local population members, whose homes or local environment could be damaged by these projects, especially major ones, in the initial stages of construction. The results of the analysis in terms of rebuilding the system of urbanization in the historic city confirms a need for the integration of territorial and social formula of the projects, in the context of sustainable development. The strong link to the alley, in particular and to the historic city, provides a distinct system of urban heritage in general, which is more than ever, highly desirable in this era of globalization.

Concerning the limits of involving tourist industry and the building of guest houses, new research in the field is being carried and it is mainly focused on the impacts of these projects. The first obtained results have indicated a trend towards rising property prices in the medina, parallel to a relative increase in living standards. In the absence of adequate accompanying measures, this trend could evict from the medina local people with limited income.

This leads us to ask new questions about implementing consensual strategies whose purpose is to oversee the ongoing processes; otherwise we would find ourselves with a "folklorisation" scenario of the built heritage. This would create a sort of obvious risk of massive consumption of heritage, which is in complete contradiction with the interests of sustainable development. This scenario, which implies negative development dynamics, would obviously act at the opposite of a development that respects the fragility of the cultural and architectural heritage of the medina.

In this sense, and while awaiting a thorough exploitation of new field research in progress, we can already confirm that the sustainability of successful guest houses experiments requires the adoption of greater professionalism. Maintaining the “sustainability” of the heritage offer, while responding to the rise of the “demand”, requires more consideration of two essential criteria: “quality” and “diversity” of this offer in the different tourism practices at the level of use and consumption.

In this context, the research findings lead to the formulation of a set of recommendations that we summarize as follows:

- Publication of the outcome of the social and territorial evaluation in restoring, and sensitizing to the importance of qualitative approaches in reaching quality at the level of the diagnosis of the process of the intervention in urban heritage, impact monitoring, and the construction of intervention models in relation to the local environment to the direction that leads to the valuation of this profile type and new trend in expertise in urban heritage in action. The institutions conviction of the viability of practical employment of this qualitative pattern in the evaluation, as a plan of action that allows the assimilation of the complex reality and therefore the direction or correction of the intervention, is in itself an essential and positive step that highlights an active engagement in the process of consensual planning and effective partnership between the institutional and technical domain and university scientific research centers.

-Thinking of the creation of the “Charter of the historic city of Fez,” a charter that may be directed to private investors who will be involved in the rehabilitation of urban heritage that is agreed upon by the institutions concerned with the management and planning of the preservation of urban heritage in action on the basis that the Charter relies on the following basic goals:

- * to approach the rehabilitation of guest houses within a set of specific and global features of the environmental scene and within the socio-cultural and environmental reality of the historic city where there is an overlap of the various components in a transversal way,

- * to override the single approach which is limited to the engineering and technical vision of heritage by adopting a more holistic approach that integrates the values of authenticity and respect of local customs and traditions. In this context, we can consider the drafting of a guide that organizes the relationship of co-existence between visitors and the local populace,

- * to evaluate the positive experiences of pioneering professional investors in the rehabilitation of guest houses by working on the dissemination, transfer and exchange of technical skills; and the capacity to communicate with the local community so that these experiences become a reference, at the level of the countries, precisely the ones comprising *Medina*. This *challenge* informs about “best practices”, and thus can be subject to employment by new investors. Here, we can seek the help of promotional supports like websites allocation.

- * to control the real estate market in the historic city by using urban documents with a legal background, and by including the necessary adjustments in terms of zoning, knowing that these amendments are imposed by the specificities of the historical urban fabric and the need to protect it from risks of the escalation of real estate speculation. These modifications may fall within the context of an outdated master plan of urbanism and planning, which is being updated at present. Taking this recommendation into account when updating the zoning process may have a double effect:

- +The protection of the densest and most vulnerable original zones part of the “historic nucleus” (9-12 century), where the equipment and facilities like commercial and religious shrines and sites of high heritage value are located,

- + The protection of the southwestern part of the historic city (century 17-19) from the intensification of the pressure faced by the high concentration of guest houses.

-Supporting and revitalizing the population’s representative mechanisms by activating the organizational structures of NGOs and their integration due to their strong representative implications and their vital strategic role as a legitimate mediator in negotiation, dialogue or consensus between the local populace, the public authorities and other agents in urban heritage under requalification. This generally requires a certain conviction that the participation of people

through organizational structures is a positive resource in the process of sustainable development rather than an obstacle to restoring and restructuring. The translation of this conviction on the ground necessarily leads to the involvement of the local populace in alleys in the projects of the establishment of guest houses, and the maintenance of this involvement and its valuation throughout the process of rehabilitation.

-Creating partnerships among Arabic countries concerned with the problematic of historic cities that constitute a “living entity”, especially with regard to the financial support for the rehabilitation projects of traditional houses with a “normal heritage” such as thinking about the mechanisms of activating the contribution of banks to accord micro-credits to medium and low-income groups (Royaume du Maroc, BM, 1996).

-Creating a network of multidisciplinary experts working in the domain of the urban heritage rehabilitation, both at the technical and the social environment level in Arabic countries, and providing tools and means of support necessary to make this network function in a scientific and practical way.

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ENDNOTES

1. The historical city of Fez extends around the old nucleus (a nearly twelve centuries old one) known as "Fez El Bali" as opposed to relatively recent extensions (dating back to the 17th 18th and 19th century), called "the New Fez". The old city with its two nuclei (the historical and the modern) covers an area of 210 hectares.
2. The creation of a specialized agency ADER-FES in 1989 was for the sake of applying programs "to safeguard the ancient city of Fez."
3. These new projects are localized in distinguished areas that originally reflect the traditional nature of the urban and social organization of neighborhoods in the historic city: These are units that are referred to locally as alleys: the alley is a semi-closed area that consists of internal paths, for the most part without access, and which is characterized by a purely residential function and by a density of social relations and a type of "privacy" that does not exist in housing units open to traffic, and where the residential function mixes with the economic functions. It is supposed that the traditional residential units attract newcomers "tourists" due to new investment projects and be open to unusual movements and activities in the alley, in addition to the expected positive and/or negative economic and social effects.
4. We mean by that in particular the humanistic approach in its geographical and axiological dimension: on the one hand, the axiological approach focuses on the Investigation of the different agents, the values that they hold and their different practices that produce urban space; this approach deals with the pattern and the process of human action. On the other hand, it concerns the typological approach with a renewal of its mechanisms in research provided that there should be an integration of both approaches.
5. This field work has started since 2001 and from that time the establishment of guest house projects has been tracked and accompanied in parallel with the monitoring of the impacts on the surrounding environment from the perspective of the local populace.
6. The interview guide was directed towards the original category "or nucleus" of investors that have created the basic structure of this project and also towards that category that came later and became a head or "pole" for each profile type: the first initiative is established in each of the distinct locations, and the ground is prepared to a group of houses built around these poles. The interview guide has been also directed towards a representative sample of the latter category in every profile type. These nuclei or poles have become at later stages a kind of technical and artistic reference for investors at the level of re-engineering successful models and at the level of the valuation of investment in new locations. The total number of respondents who represent the interviewed investors approximates 50 of the total number of houses under rehabilitation in the field, and which amounts to approximately 60 guest house classified and legally recognized.
7. 180 household owners were interviewed; they are distributed in all the alleys concerned with projects and represent a quarter of the total number of families inhabiting it. This sample covers diverse housing, social, and economic positions that reflect a complex variety of representative cases.
8. The personal profile of the investor, his qualifications and motives, a diagnosis of the specificities of the *riad* and the procedural execution of the project, management style, the nature and logic of the adopted rehabilitation, and forms of openness to the area and the neighbouring community of the project.
9. Identification of the interviewed characteristics of the family; logic of stability in the historic city, its relationship to the project in the alley and finally an evaluation of projects by the population including their reactions and forms of openness and communication.
10. The implementation comes in two forms: a donation to the population and the artisans who wish to rehabilitate their homes or workshops, a conditional donation in the range of 30% of the total amount invested by the beneficiaries. Despite the modest results at the level of achievement, this component remains an important experimental workshop.
11. First class guest houses are required to be located in a carefully selected site, with good public lighting, and should have a banner bearing their name and their rank. The regulating law also requires that first class guest houses have a parking lot guarded day and night.
12. This guest house has been established in 2001 and it is a *riad* that dates back to the eighteenth century and is located in the alley of "Arsat Bennis" in the neighborhood of "Douh" (south west of the city), in an area of 1700 square meters, and which has been rehabilitated by the architect/owner of the project along the lines of Arab-Andalusian style; it comprises 11 suites and luxury rooms.
13. The guest house "Riad La Maison Bleue" has been established in 1997 by the rehabilitation of a family house obtained by inheritance, and it is located in the Independence Square in the Batha district (south west of the city). The *riad* covers an area of 250 square meters; it has been originally in a relatively good form, and is one of the Andalusian architectural types that have been rehabilitated by the owner who works in the tourism sector. This house consists of 14 rooms.

What Else Do Design Professionals Need to Know About Sustainable Buildings Investment? A New Assessment Approach

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ABSTRACT:

Design professionals typically do not report the true value of sustainable building to their clients in reliable and understandable terms. It is necessary for designers, particularly architects, to understand how investment professionals value their investment choices, what techniques traditionally they use to evaluate their alternatives, and how they account for risk and uncertainty in their investment decision making process. In this paper, first, the deficiency of current building performance tools, such as building simulation programs, sustainability certifications, simple financial methods and building performance-based techniques in evaluation of sustainable buildings are presented. Recommendations are then provided regarding the additional knowledge of financial, risk and uncertainty modeling that designers need if they want to estimate and communicate a more complete assessment of value to the real estate decision makers. The Discounted Cash Flow approach is explained as a financial method, capable of incorporating all costs, benefits and risks for estimating the value. The Monte Carlo simulation is suggested for modeling uncertainties inherent in the evaluation process. Finally, a new assessment process is proposed to align the environmental and social benefits with economic returns of sustainability and to thoroughly evaluate the true value of sustainable buildings, while explicitly including uncertainty.

CONFERENCE THEME: on measurement: quantifying sustainability, are we using the correct measures?

KEYWORDS: true value of sustainability, sustainable building assessment techniques, financial performance, risk, uncertainty

I. SUSTAINABLE BUILDING INVESTMENT

Sustainable building investment is not a new concept, it has been around for more than a decade in the United States and longer in Europe. However, with all of the concerns about climate change, global warming, and rising energy costs in recent years, sustainability investment becomes a mainstream consideration in planning and design of most building development, both new construction and retrofit.

Substantial evidence suggests that demand for sustainable buildings has increased over the past several years. Owners, government regulators, investors and designers are the primary drivers in this shift in attitude toward sustainability. Many space users have indicated that they are prepared to pay more for rent or for purchasing sustainable buildings with the expectation to reap the benefits, such as operational cost savings, improved corporate reputation, and health and productivity. Most investors and owners of existing buildings have declared that they would not undertake a retrofit of a building without considering investment in at least some sustainable features. These professionals believe that the benefits of sustainable building investment will increase in coming years; and therefore, they are not only concerned about today's market demand, but also about the possible growing future demand. "The decision for real estate investors and developers today is not whether new projects should be green, but rather how green they should be" (Smith, 2007, p. 1). Even during the recession, owners that fail to adapt quickly to the new standards may find their viability jeopardized" (Nelson, 2009).

I.1. NEW RESPONSIBILITIES OF DESIGN PROFESSIONALS REGARDING SUSTAINABLE BUILDINGS

There are two groups of decision makers who are involved in the development process of a building: design professionals, who are involved in technical decision making processes, and property



Figure 1: Communication between Design and Property Professionals

professionals, who are involved in financial or investment decision making processes. Design professionals include architects, engineers, etc. Property professionals include real estate investors, developers, valuers, lenders, etc.

As illustrated in Figure 1, design professionals would generally propose design alternatives and provide property professionals with information concerning the impacts of their design suggestions (costs and benefits) on building performance. Property professionals process the cost-benefit information with their own decision-making techniques, and make the final decision about whether or not to proceed with investing in those proposed alternatives. Essentially, property professionals make their investment decisions based on their predictions of value, both revenue and risk. Private investors need to ensure that the projects they are investing in will generate a reasonable and competitive rate of return in the market with the lowest possible risk; they need to know if the risks associated with their investment are adequately compensated by expected returns generated—risk and revenue trade off.

It is important to note that the sustainable building investment procedure is not essentially different from that of a typical property investment analysis from risk and return perspectives. In fact, a thorough communication of value, both revenue and risk, is much more critical when analyzing a sustainable building / feature investment opportunity, due to insufficient market data, and limited knowledge and experience with sustainability investment of property professionals. Real estate investors/owners need to fully understand how sustainable building features affect the value of their investments. They must recognize the financial return they might have received above the amount they would received when not investing in these features. Thus, a clear, comprehensive, and reliable presentation of value of sustainable buildings in the way that property professionals could understand and apply in their decision making process is vital. *This will add a new task for design professionals involved in sustainable buildings planning and design to not only thoroughly evaluate the building performance but also communicate the added value to the decision makers.*

It is the responsibility of design professionals to communicate the full scope of costs and benefits of sustainable features to property professionals. Designers should be able to explain how their sustainable design alternatives impact the building performance and how those impacts could affect the property value. This information, if presented in a reliable and understandable language, will enable real estate investors/owners to make more informed decisions about sustainable building investment. Regarding the new assignments and business activities of architects and engineers, Lützkendorf and Lorenz (2005) have also stated that “in the future, clients will ask about the effects of these design and planning solutions on overall building [financial] performance. This creates a new client need that the design team can fulfil by providing building related information relevant to valuation and rating purposes” (p. 231).

Currently, design professionals do not report the true value of sustainable building to their clients, due to their incomplete or unreliable evaluation methods and lack of their knowledge of the investment decision making process. *Communicating the financial performance of sustainable buildings reliably requires performing more sophisticated financial and statistical analyses than what designers traditionally do.*

In order to better communicate to owners and investors, it is necessary for design professionals, particularly architects, to understand how property professionals value their investment choices, what techniques traditionally they use to evaluate their alternatives, and how they account for risk and uncertainty in their investment decision making process. Having knowledge of the investment decision making will enable designers to better organize and align their technical ideas and suggestions

with the owners/investors goals. According to the USGBC (2008), “without consistent and reliable documentation of benefits, it is difficult for many building owners to commit to appropriate high-performance building. Without robust financial tools that address sustainability issues, financial institutions can not readily meet their fiduciary and statutory obligations in funding innovative and transformative technologies” (p. 16).

This paper will introduce appropriate financial, risk, and uncertainty methods that are used by investment communities for analyzing investment decisions.

1.2. SUSTAINABLE DEVELOPMENT AND BUILDINGS

It is generally accepted that sustainable development has three categories of benefits including environmental, social and economic. Buildings that have the potential to contribute to sustainable development simultaneously provide all three benefits to a lesser or greater extent. A growing body of evidence suggests that the building industry has become mature enough to recognize that all three areas of benefit, particularly those improving health and productivity, could have positive impacts on property value. Health and productivity are known as central parts of the social benefits of sustainability. Until recently, health and productivity have received less attention among the private investors because there are substantial risks and uncertainties involved in the quantification of their benefits and investors are not able to account for them in their costs-benefits analysis. However, these professionals have now realized that social aspects of sustainable development, such as adaptability, functionality, health and productivity, could significantly influence total real estate costs and users demand, and therefore, should be taken into account in the costs-benefits analysis of sustainable buildings.

Muldavin (2010) has argued that from a financial perspective, sustainable property is what regulators, potential space users, and investors in the subject property defined as a sustainable property. “Proper financial analysis of a property requires explicit consideration of the potential benefits that will accrue through meeting regulator, user, and investor thresholds for sustainability” (p. 17). Thus, simultaneous consideration of all the sustainability benefits that might impact users’ satisfaction is critical in understanding the full scope of costs and benefits, and therefore, the true value of sustainable buildings.

1.3. COSTS, BENEFITS, RISKS AND UNCERTAINTIES ASSOCIATED WITH SUSTAINABLE BUILDING INVESTMENT

“The benefits [of sustainable buildings] range from being fairly predictable (energy and water savings) to relatively uncertain (productivity/health benefits). Energy and water savings can be predicted with reasonable precision, measured, and monitored over time. In contrast, productivity and health gains are much less precisely understood and far harder to predict with accuracy” (Kats, 2003, p. v). Unfortunately, the majority of current sustainable building investment decisions are solely made based on tangible cost savings, while full costs and benefits of sustainability are beyond cost savings. For example, improved worker health and productivity in an office building may contribute to significant cost savings for employers because of lower absenteeism and recruiting costs. Achieving sustainability certification, such as LEED, would increase the reputation and marketability of the subject building, which would lead to higher absorption rates and higher value.

Risk is a significantly important component of the costs-benefits analysis. No assessment of a sustainable property value would be completed without a full assessment of risks, both positive and negative. The positive risks may increase the potential benefits and negative risks may increase the potential costs. “Reduced risk is perhaps the most significant benefit of sustainable property investment” (Muldavin, 2010, p. 126). Later in this paper, it is explained that there is also uncertainty inherent in each step of sustainable buildings valuation. A clear and well-supported presentation of risk and uncertainty of achieving the expected value of sustainable buildings is critical in preventing underestimation or overestimation the value of sustainable building. If designers ignore risk and uncertainty of sustainable building investments in their analyses, they might mislead their clients. This would result in destroying their reputation and jeopardizing their consulting business.

Some of the potential benefits associated with sustainable building investments that are often ignored in current analysis procedures include: access to state or federal government incentives; tax and insurance benefits; better financing options; contributing to achieving green certifications; reduce the carbon emission; improve indoor air quality, daylighting and thermal comfort (environmental benefits); increase adaptability, serviceability, and functionality; improve health and productivity (social benefits); increase property reputation and marketability; and increase asset value or revenue due to improved appeal to regulators, space users and investors, which would lead to higher rent, higher occupancy, lower turnover, etc.

Potential risks inherent in sustainable buildings investment include: reduce the risk of losing value due to functional, economic or physical obsolescence; reduce the risk of losing users and investors due to availability of sustainable buildings in future markets; reduce the risk of inaccuracy of projected building performance; reduce energy consumption volatility; reduced liquidity risk; and reduced legislative risk (Bozorgi & James, 2010a).

Consequently, both tangible and intangible benefits could contribute to the financial value of sustainable buildings in the way that investors are interested in. *Without a simultaneous consideration of the full scope of costs, benefits, risk and uncertainty associated with sustainable building investment, understanding their true value of is not possible.*

2. CURRENT SUSTAINABLE BUILDINGS ASSESSMENT METHODS

Tools and techniques that are currently widely used for assessing building performance are categorized in the following four types. The results of these methods are typically accepted as the basis for making technical and investment decisions by both design and property professionals. In this section, it is explained that why none of these tools on their own are sufficient to rely upon for making major high-quality investment decisions at the property level.

2.1. GREEN BUILDING CERTIFICATIONS

Current Green Building Certifications and Energy Rating Systems, such as LEED, BREEM, and EnergyStar are very often used as a basis for comparing the performance of sustainable buildings. However, these certifications cannot be the sole basis for defining sustainability for the purposes of major investment decision-making because of the following issues:

First, they have been designed to measure the environmental impact of sustainability, and therefore, due to their environmental outcomes rather than financial outcomes, are not able to communicate the overall performance of sustainable building to the investment decision-makers. Second, they do not provide any detail about the sustainable features employed in the building and many of the sustainable features that have contributed in achieving the certification may not have a significant direct impact on property performance from a financial perspective. And finally, many buildings might have employed valuable sustainable attributes that could influence their market value but are not certified; therefore, relying upon certification may ignore the impact of those sustainable features on financial performance and may lead to undervaluation. “That suggests that something more granular than Energy-Star or LEED is needed to capture the green design elements that contribute to enhanced environmental, economical, and social performance which in turn link to building value” (Mudavin, 2008, p. 9). However, it is very important to consider these elements in the financial analyses as many studies have shown that they made a positive contribution to the overall market value of a sustainable property because of their impact on reputation and marketability.

2.2. BUILDING SIMULATION PROGRAMS

There are many Building Simulation Programs (BSPs), such as DOE 2, Energy-Plus, Radiance, Computational Fluid Dynamics (CFD), etc. developed to evaluate building performance indicators such as energy consumption, daylighting, and indoor air quality. These programs are typically used to provide supporting data for achieving certification to perform simple cost-based financial analyses.

The primary issues with directly using the results of these programs for making major investment decisions are as follows:

First, these tools are primarily designed to forecast impacts of design decisions on environmental performance indicators and do not take into account other aspects of sustainable building performance /benefits. Second, their outcomes are typically described in technical terms rather than financial. Most of these tools are well developed to evaluate building performance, but fail to properly link indicators to financial performance and do not translate the technical details to a more understandable language. According to Lorch, Lützkendorf, & Lorenz (2007), “the largely technocratic approach is, on its own, not enough to bring about the necessary change. What is needed is to encourage dialogue and learning between the construction community and practitioners from the property, finance, insurance and banking industries” (p. 1). And finally, the simple financial analyses that these tools perform are based on simple estimation of cost savings, payback period and simple return on investment (Bozorgi & James, 2010b).

2.3. SIMPLE FINANCIAL METHODS

The financial analysis techniques traditionally used by real estate investors, owners and lenders for assessing the financial performance of sustainable buildings include: Simple Payback (PB), Simple Return On Investment (ROI), Energy-Star financial tools, etc. These approaches primarily focus on initial development cost and operational cost savings, and ignore the full scope of costs and benefits.

The full costs and benefits of sustainability—environmental and social issues along with financial return—are beyond cost savings and traditional sustainability analysis (Muldavin, 2010); and ignoring them, may undervalue the sustainable investments and exclude many profitable investment opportunities from consideration, which ultimately would lead to underinvestment in sustainability. Nevertheless, because of their simplicity, these types of simple analysis are used very often; they might be good enough to address minor investment decisions, such as minor, but are not sufficient for major retrofits or acquisition decisions.

2.4. BUILDING PERFORMANCE-BASED METHODS

Building Performance-Based Methods such as Life Cycle Costing (LCC), Life Cycle Assessment (LCA), General Cost-Benefit Analysis (CBA), or Value Engineering (VE), are widely used by decision makers, both technical and financial, to evaluate the performance of a sustainable building over its life. The primary problem with most of these methods such as LCC or VE is the cost-based nature of their financial analysis, which would lead to the ignorance of other non-cost benefits of sustainability investment. LCA-based techniques are recognized as one of the best approaches for evaluating the environmental and some of the social aspects of sustainability. They are well developed to incorporate building performance over its entire life cycle. While LCA “takes the issue of occupant health into consideration, there is less focus on occupant satisfaction, functional fit and productivity” (Lützkendorf & Lorenz, 2005, p. 224). Therefore, to date, performance-based approaches are unable to deal with all aspects of sustainability simultaneously. Furthermore, they are not well suited to account for sustainability investment value, risks, and uncertainties simultaneously in their evaluation process in the way that investors require.

In summary, current assessment methods and analytics do not simultaneously incorporate all of the costs, benefits, risks and uncertainties of sustainability investment, nor represent them in the way that assists investors to make informed investment decisions. Design professionals need new assessment methodologies to consider all impacts of sustainability on property market value as well as their associated uncertainty and communicate the added-value in appropriate terms to be understood and utilized in the investment decision-making process. This approach requires more sophisticated financial/valuation techniques for estimating the property value and more sophisticated statistical techniques for incorporating uncertainties of a sustainable building valuation.

3. PROPERTY VALUATION

Property valuation is the practice of developing an opinion of the market value or worth of a real property. “The purpose of a valuation is to forecast the future benefits of a property and calculate this into a current price. The accuracy of that valuation will depend on the ability and skill of the valuer in understanding the factors that determine values, and the weight that those factors hold” (Bowman & Wills, 2008, p. 12). Below, three basic approaches that are traditionally used by property professionals to determine market value are presented. All three approaches may not be applicable for all situations or may not result in accurate estimates for market value. Valuers must select the most appropriate approach based on type of property investment (new or existing property) and available data, in order to provide the most accurate indication of market value.

1) Cost Approach: This method estimates the value of a property based on the sum of the cost of the land and depreciated (present value) cost of reproduction and replacement of existing improvements. This approach could be appropriate when costs data is available and market conditions are stable. As Chappell and Corps (2009) stated, given limited national cost estimating database for sustainable buildings, this approach would likely prove less dependable and accurate, particularly for an older, existing property. (p. 14).

2) Sales Comparison Approach: This method estimates the value by comparing the subject property with transaction data (sales data) of similar properties in the surrounding or comparable data. This approach could be most useful when sufficient empirical data of similar properties is available. This approach is not yet appropriate for sustainable building valuation due to current insufficient market data for comparison. Often, sustainable buildings are compared based on their certification level. The challenge with this approach is that sustainability can be achieved through a variety of different features. Even two LEED certified buildings with the same level rating might have employed different systems and design strategies in achieving a certification. They might have different building performance and financial performance, and therefore, should not be considered comparable. Until more time passes and more market evidence are generated, this approach remains inappropriate for sustainable building valuation.

3) Income Capitalization Approach: This approach estimates value based on the present value of the income stream produced by the subject property. This is the primary valuation method for income producing property such as office or multi-family buildings. The methods used under the income approach primarily fall into the three categories: direct capitalization, discounted cash flow, and gross income multiplier. The discounted cash flow model, as the most common technique, is described below:

3.1 TRADITIONAL DISCOUNTED CASH FLOW (DCF) METHOD

One of the powerful valuation methods currently used in real estate investment is the DCF method. This technique evaluates the present value of the projected future cash inflow and outflow over a holding period. The DCF model is able to deal with the complexity of various factors involved in real estate valuation and to incorporate its related expenses, revenues, and risks simultaneously.

As shown in Figure 2, the DCF model takes the explicit assumptions on future rents, occupancy rate,

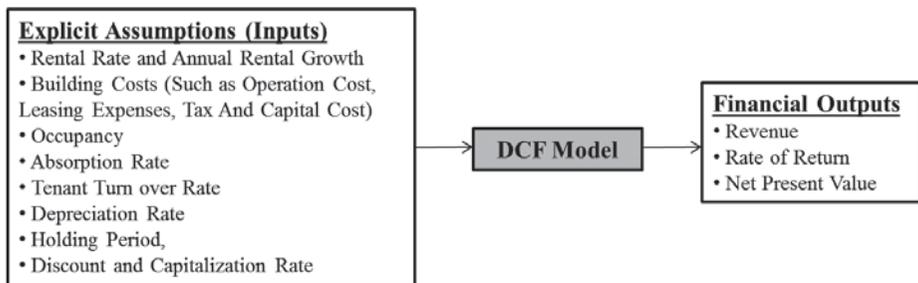


Figure 2: DCF Model Inputs and Outputs

operation costs, etc. as inputs and estimate the financial outputs such as revenue, rate of return, or net present value. These financial outcomes are the metrics that investors use for evaluating investment options. The more accurate DCF inputs would result in the more accurate financial outputs. It is the responsibility of valuers to do as much market research as possible and forecast the DCF assumptions.

For example, one of the most important assumptions in a DCF model is the discount rate that is used to calculate the present value of all future cash flow streams. The discount rate reflects the risk associated with receiving the projected cash flows. The greater discounted rate will be selected for riskier project while the lower discounted rate will be selected for the projects with lower level of investment risk.

This approach currently is viewed as the most appropriate approach to provide a more reliable indication of market value of sustainable property. *We encourage design professionals to utilize the concept of the DCF approach in lieu of simple PB, simple ROI, or LCC for estimating the financial performance of sustainable buildings.* With the DCF method, potential direct and indirect costs, benefits and risks associated with sustainability investment, stated previously, could be considered in generating the investment's revenue. Consideration of both revenues and risks in the valuation process will allow designers to provide their clients with the true value of sustainable buildings. It should be noted that using the concept of DCF approach requires sufficient market data upon which to rely for determining DCF inputs, such as future rents, occupancy, etc. With the absence of sufficient market evidence for sustainable buildings, there is a substantial uncertainty associated with predicting DCF inputs. However, even with current limited hard data, DCF approach gives the users a proper financial method to acknowledge and consider factors that have impacts on future property value, rather than ignoring them in the assessment process and misleading the final decision makers.

4. UNCERTAINTY

4.1. DEFINITION OF RISK AND UNCERTAINTY

Risk is known as a situation in which alternative outcomes and their probability of occurrence are known, where as uncertainty is a situation where information about future outcomes and their probability are not known. "Uncertainty is anything that is not known about the outcome of a valuation at the date of the valuation, whereas risk is the measurement of the value not being as estimated" (French & Gabrielli, 2005, p. 81).

Probability distributions are the primary quantitative vehicle used for explaining risk in the risk management analysis methods. The probability distribution describes a range of possible values and the probability of any value within any subset of that range. All variables that are uncertain could be represented with probability distribution, and their associated risks could be estimated using statistical approaches based on specifications of a range of most likely values (means) or extreme values. The variability of the expected return about its mean is used as a description of risk, and

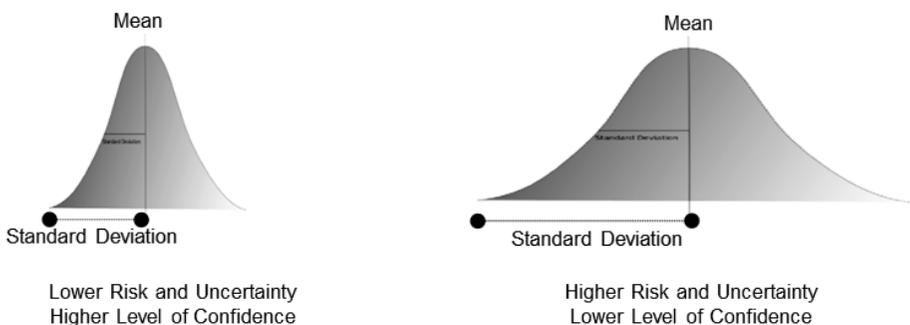


Figure 3: General Interpretation of Shapes of Normal Distribution (Bozorgi & James, 2010b, p. 3:25)

standard deviation is commonly used as a measure for spread of probability distribution. As shown in Figure 3, the tighter distribution of outcome with smaller standard deviation represents the lower risk and uncertainty and high level of confidence in achieving the expected outcome (mean). Flat distribution with large standard deviation denotes the great degree of risk and uncertainty and low level of confidence (Bozorgi & James, 2010b, p. 3:25)

4.2. UNCERTAINTY IN PROPERTY VALUATION

There is general agreement that there are risks and uncertainties associated with property valuation procedures that need to be identified, assessed, and reported in a way that can be understood and analyzed by investors or end users. For example, the uncertainty of DCF inputs (explicit assumptions about future factors) or the risk of not achieving value or rate of return as predicted in DCF (estimation of DCF outputs). Acknowledgement of uncertainty inherent in the valuation process would provide investors with useful information about the level of confidence in receiving their expected return and therefore insight

Considering uncertainty involved in sustainable buildings valuation, it is vital that design professionals account for uncertainty when analyzing the value of a sustainable building; otherwise, the outcomes of the valuation process may be underestimated or even overestimated, and may lead to inappropriate investment decisions. In the DCF model, the inputs are included as single point estimates and therefore, the uncertainties of the DCF assumptions are not taken into account. Inability of the traditional DCF model to deal with uncertainty in the valuation process requires a more sophisticated approach to explicitly account for uncertainty.

4.3. MONTE CARLO SIMULATION (MCS)

"Monte Carlo analysis is a widely used numerical computational analysis tool that draws information from input probability distributions, applies the data in a process, and generates an outcome distribution" (Jackson, 2008, p. 137). This technique is able to account for uncertainties by allowing for a range for each input and its correlations at the same time, perform a random probabilistic sensitivity analysis and model a range of possible outcomes. In the MCS, simulation data is processed and ranges of final outputs are estimated through the base model which describes the relationship between inputs and outputs. The results allow decision makers to better analyze and interpret uncertainty and provide them with more reliable information than a few discrete scenarios. This method is also suggested to include various uncertainties of valuation by describing the range of possible values instead of a single-point estimate of value in the DCF model.

We encourage design professionals to use the MCS for modelling uncertainty and estimating the final financial performance indicators of sustainable building. The base model for this simulation, which describes the relationship between inputs and outputs, is built based on the DCF approach. This probabilistic model takes and analyzes the same DCF inputs and outputs but replaces single estimate points with appropriate ranges and probability distributions. The MCS incorporates the uncertainties of achieving the DCF inputs and articulates the risks related to receiving these outcomes.

5. NEW ASSESSMENT PROCESS

We propose a new assessment approach to estimate the true value of sustainable building. *Unlike the current sustainable building assessment process, this new process explicitly connects performance estimates from the design professionals to the property valuation techniques to communicate to property professionals in a common language. With this new approach, designers could also better understand the impact of their design decisions on financial performance of a sustainable building at the design stage, which would result in more viable designs.* In development of this process emphasis has been placed first, on the simultaneous consideration of environmental, social, and economic benefits in context of value, and second, on the explicit consideration and articulation of valuation uncertainties. The process is illustrated in Figure 4:

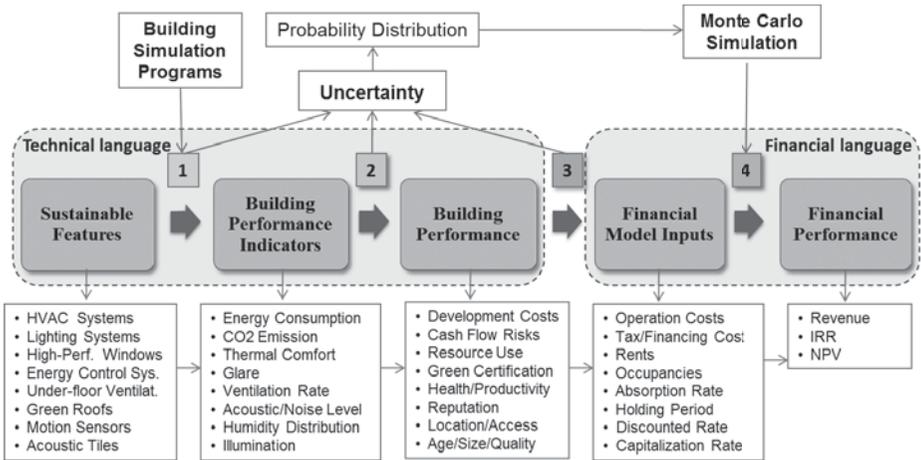


Figure 4: A Process for the Valuation of Sustainable Buildings

The process begins with taking the sustainable features and estimating their related building performance indicators through the appropriate BPSs. For each selected system, certain building performance indicators can be determined, for example, energy consumption as an indicator of energy performance, or ventilation rate and pollution as indicators for indoor air quality. Then, depending on the system and its performance indicators, the selected systems would be modeled through the appropriate BPS. It might be necessary to model a particular sustainable feature with multiple BPSs as most of the sustainable features have impacts on more than one building performance indicators which directly or indirectly contribute to the value of building. For example, using an energy efficiency HVAC system reduces operational costs but at the same time may improve indoor air quality which may improve health and productivity.

It is very important that designers realize that any building performance indicator that is of interest to occupants could play a role in the financial performance of a building; therefore, a thorough evaluation of all performance indicators that might be influenced by a sustainable feature is required.

Second is to determine the building performance in terms of both sustainable and non-sustainable factors. Factors related to sustainable features include development costs, occupant satisfaction, and health and productivity, contribution sustainable certifications, achievable incentives, marketability, risks, etc. Non-sustainable building performance, which are not related to sustainable features but critical in valuation of a property, include location, access, age, size, etc. When evaluating a sustainable building, some sustainable factors such as costs, possibility of achieving certification or incentives, can be estimated relatively easily based on available data, guidelines, regulations and BPSs outcomes. However, factors such as users' satisfaction, and health and productivity are more difficult to measure precisely.

Third is to select key financial model inputs based on building performance estimates, which includes all costs, benefits and risks associated with the sustainable building investment. This is the translation step from technical to financial language. The traditional DCF approach is suggested as a base model for estimating the true value of sustainable buildings. Valuers consider all sustainable and non-sustainable factors, determined in the previous steps, simultaneously, assess the market responses (regulators, space users and investors' demand) and forecast the DCF model inputs.

Last is to calculate the value based on the DCF model inputs. Monte Carlo simulation with a base case built upon the DCF approach is suggested to estimate the final financial performance indicators while modeling uncertainties.

5.1. CONSIDERING UNCERTAINTIES INHERENT IN SUSTAINABLE BUILDINGS VALUATION

As stated previously, there is a certain amount of uncertainty associated with measuring the outcomes of each step in the valuation process. Some of these uncertainties include:

uncertainty associated with forecasting building performance indicators by building simulation programs; uncertainty associated with achieving any certification or energy label; uncertainty inherent in determining the building performance, such as health and productivity based on projected outcomes; uncertainty associated with future energy price escalation, interest rates, or inflation; uncertainty associated with forecasting the financial model inputs, such as future rents.

These types of uncertainty need to be considered in order to communicate reliable outputs to final decision-makers. *Specifying a probability distribution for each uncertain variable, involved in the process, is suggested in order to incorporate and articulate their uncertainty.*

It should be noted that this paper is not intended to provide information about estimating and collecting data required for each step for the proposed process. A thorough discussion about incorporating the various factors in the process will be presented in future publications by the authors.

CONCLUSION

Design professionals are not able to estimate and communicate reliable financial performance data for sustainable buildings if they solely rely on their current approaches and knowledge. They need to utilize more sophisticated financial/valuation and statistical techniques in order to present the true value of sustainable buildings to property professionals. While designers are not expected to perform a thorough market analysis and predict accurate financial model inputs, they are expected to provide comprehensive, reliable and understandable information to their clients and assist them in making investment decisions. They are expected to acknowledge that benefits of sustainable building investment are beyond cost savings and to consider full costs, benefits, risks and uncertainties in their analysis. The suggested methods, DCF and MCS, are examples of such techniques that would enable designer to do the above.

Therefore, the authors believe educating the design professionals, particularly architects, about property valuation and the investment decision-making process, and providing them with a defined procedure to follow to understand the impact of their design decisions on those factors that are important for the property professionals, could be helpful toward communicating the true value of sustainable buildings and driving their market.

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Cultural Cartographic Archive: empowering communities through archi-digital technology

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ABSTRACT:

This paper will present research that was conducted with the goal of developing a digital archive using interactive media and open source applications to generate a multi-faceted public community database. Based in the Embudo Valley of northern New Mexico this research documents the architectural and cultural landscapes of this historic community.

The data model is a collaborative, interdisciplinary effort that re-examines the boundaries of traditional architectural research and moves towards a working model incorporating a faculty-student team whose expertise lie in a variety of disciplines. Areas of expertise include landscape architecture, historical preservation, architecture, community and regional planning, economics and demographics, informatics and digital visualization.

This demonstration project evolved into a multi-media data repository intended to both empower and enable the community to take control of their future by engaging in conversations with local and global communities.

INTRODUCTION

The project site, Embudo/Dixon, New Mexico, evolved from previous research that focused on documenting the architectural and urban evolution of Albuquerque, New Mexico. The Virtual Albuquerque Project [VAP] (Castillo 2007) was conceived around a digital media format that used a GIS (Global Information Systems) core to investigate a broad spectrum of topics related to the evolution of the urban context. A beta database formed through definition of a series of layers that created a holistic overview of the environment. The categories (or layers) that were documented in the database included architecture, infrastructure, culture, history and geography.

Based in the rural context of the Village of Embudo, New Mexico, this new research has been built on the core data structure of the urban VAP. However, with new technological evolutions, more efficient communication tools have been created that redirected our research to an open source platform. This framework allows for community input and greater flexibility in populating the datasets and documenting cultural evolution of people and place.

HISTORY OF SAN ANTONIO DEL EMBUDO

Northern New Mexico represents the remote periphery of the Hispanic New World. First explored in the late 16th and early 17th centuries by conquistadores seeking riches, these explorers instead found an arid high-desert landscape filled with indigenous people, some living in permanent and architecturally sophisticated villages or pueblos, as the Spanish called them, while others, like the Navajo and Apache, lived as hunters and gatherers. Nevertheless, the story is the same as that of the entire Western Hemisphere, that is, the land was claimed for God and the King by the dominant European group, which in this case was Spain. The first Spanish expedition to establish a settlement was that of Juan de Onate, who arrived at the Tewa-speaking Pueblo of *Ohke* (renamed San Juan de los Caballeros and San Gabriel) in 1598, establishing primarily a settlers compound. As early as 1608 Onate began moving his colonists approximately 25 miles southward to the more defensible location of present-day Santa Fe. Sections of land were identified by settlers and granted by the Spanish governor. In 1680 the Pueblo people of the area banded together and attacked the first group of Spanish colonists, killing many, driving the survivors first to Santa Fe then out of New Mexico

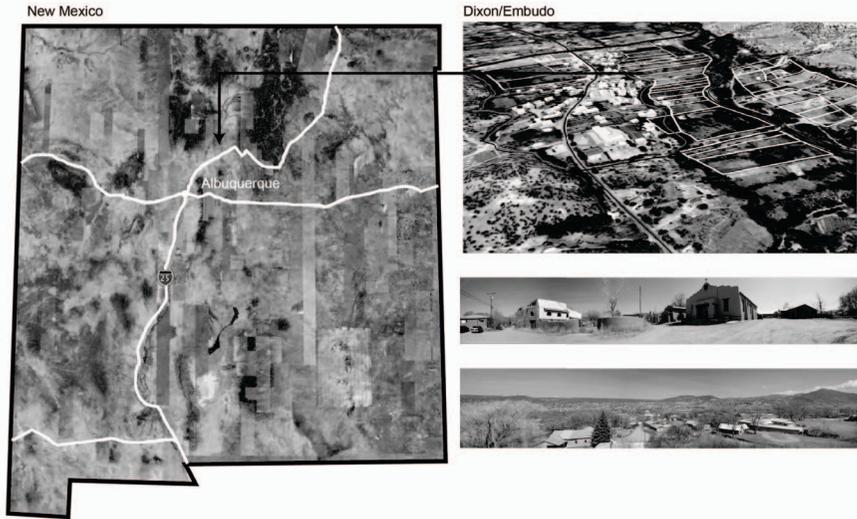


Figure 1: Research Area Map Castillo, (T.B., 2011)

altogether. The Spanish were tenacious and 13 years later another expedition of soldiers and settlers led by Diego de Vargas arrived in northern New Mexico, this time determined to stay. In 1693 de Vargas established a presidio in Santa Fe (Weber 1992) and immediately thereafter settlers were encouraged to establish villages following settlement patterns outlined in the “Law of the Indies” (Rivera 1998). The site for this research, San Antonio del Embudo, was one of a string of these land grant villages established approximately sixty miles north of Santa Fe.

The fertile land in northern New Mexico is very shallow and primarily exists in narrow riparian bands along rivers or in valleys adjacent to high mountain areas. The Embudo Watershed is formed by the steep Sangre de Cristo Mountains, the tallest peaks of which receive significant snow, enough to maintain some modest year-round snowpack. This watershed is broadest near the high peaks on the eastside of the Rio Grande gorge and narrows like a “funnel” (*embudo* in Spanish) as the tributaries drain westward towards the Rio Grande. Existing in this watershed when the settlers arrived, and inhabited still, is the indigenous Pueblo of Picuris.

The original settlers of the Embudo valley were subsistence farmers who set about the task of broadening the arable land of the valley by designing a system of *acequias* (gravity-flow irrigation ditches) that divert water at various points from the Rio Embudo to irrigate cultivated fields. This system is in use to this day.

ACEQUIAS

Both the native Puebloan people and the Tlaxcaltecan settlers who arrived with the Spanish were familiar with water harvesting techniques and dryland agriculture. However, it was the Arabic influenced Spanish who introduced their acequia tradition and with it the concept of repartamiento, that is, the system of water sharing and common ownership among the *parciantes* (irrigators) (Rivera 1998). The acequia infrastructure reshaped the New Mexican landscape and established a socio-political structure for its villages. No one owned the water, rather it was managed by the community of owners and users. Water was allocated based on its availability and the size of the *parciante*'s property. When, in 1848, New Mexico Territory found itself within the U.S. borders, its relationship to water governance changed. The system became one appropriated by priority, “first in time, first in right”. In 1907 a Territorial Water Code supported the commodification of water by allowing water rights to be severed from the land, thus furthering the erosion of community water rituals (Santistevan 2008).



Figure 2: Historical Map Dixon/Embudo 1910

Still in many New Mexican villages, and more specifically in Embudo, water distribution and maintenance of the acequias is managed by a group of community volunteers (*Comision de Acequia*) and supervised by a *mayordomo* assigned to each acequia. The mayordomo supervises the annual spring *limpia de la acequia* (ditch cleaning) as well as the schedule for and quantity of water available to each *parciante*. Along both sides of the acequias are community easements available to the mayordomo and *parciantes* 24 hours a day (Crawford 1998). Property in this region is characterized by the long lot, with a building/agricultural land ratio of 1/3 - 2/3 and an acequia system that delivers water on the property's high side. Thus water in this region shapes ritual, relationship, common and private space. Sacred space in New Mexico, as in all of New Spain, was shaped by the church and supported by the Laws of the Indies (Rivera 1998). No matter how small, nearly all of the villages in this region have a plaza with a Catholic church on one side and a *sala filantropica* (community hall) on the other (Rivera 2010); Embudo is no different. Interestingly unique to Embudo is an easement, now overgrown, linking the two spatial anchors of the valley, the plaza and the river. It is for this reason that the research team chose to center its study area on Embudo's historic plaza expanding outward approximately one-quarter mile in each direction. In doing so the study area also embraced the Plaza's adjacent acequias, the Acequia de la Plaza and the Acequia del Llano.

ARCHITECTURAL DOCUMENTATION AND THE UNEXPECTED

Developing a team that would include students from various disciplines was essential to address the broad range of topics articulated at the project's inception. Selected team members had backgrounds in historic preservation, architecture, community and regional planning, landscape architecture, economics, demographics, informatics and digital visualization. The team was well prepared to research the village's history, survey and map the landscape and the acequias in order to identify ways to assist the villagers with contemporary problems facing the acequia system. The team did find some structural issues primarily caused by invasive plant and animal species and some unfortunate engineering decisions, however, as the project progressed the team became convinced that the architecture of the waterways was endangered by a series of economic and sociological changes in the village that has unraveled the "community of interest and ethic" that until the mid-20th century had maintained an agrarian lifestyle supported physically, politically and spiritually by the acequias. The team began to recognize recurring themes, previously undocumented, that surfaced only in

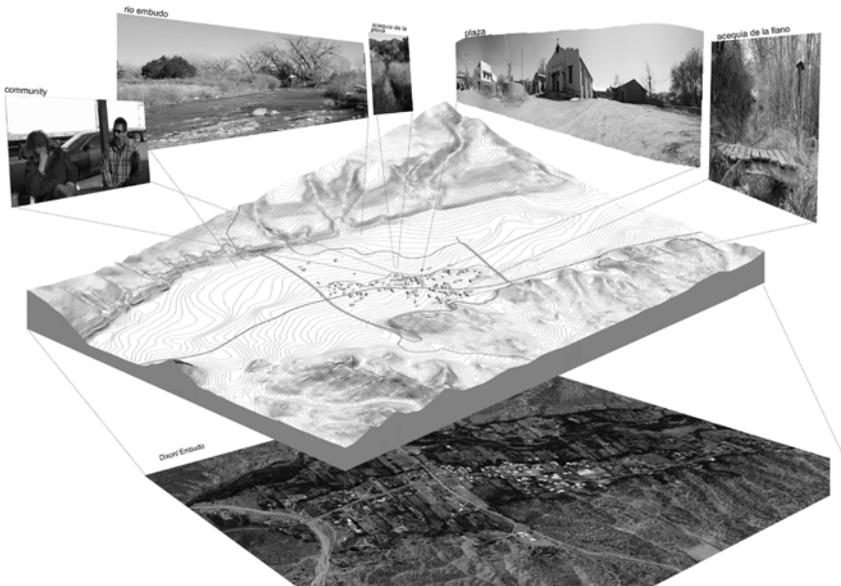


Figure 3: 3d Interactive Interface , (T.B., 2010)

conversation for example 1.) the effects on the village’s labor-force when the men from Embudo began commuting daily 11/2 hours each way to work at the Los Alamos Laboratory, 2.) the effect that World War II and television had on a generation that was no longer satisfied with the isolation of a small village dependent on subsistence agriculture and, 3.) the loss of cultural identity Embudo (now called Dixon) experienced when a group of newer residents initiated an art studio tour, re-imagining the village as an artist enclave. In order to identify and verify these and other historical and sociological indicators the team determined it was necessary to conduct oral interviews with the longtime residents of the area.

CULTURAL MEDIA ARCHIVE

Utilizing the information acquired from the VAP, a digital model was developed that had potential application in rural settings. The majority of the population of New Mexico still resides in rural environments providing the opportunity to recalibrate the research model to articulate and positively impact the evolution of a community. Embudo, New Mexico was selected as a rural location to pursue because of its historical diversity and the relationship of the people to the land. Primarily an agrarian community, the residents have maintained a strong cultural tradition based on a communal infrastructure of water. The acequia is a complex system of waterways that forges a democratic social network. The relationships associated with this infrastructural network provided an opportunity to use digital mapping and digital media techniques as a means of analyzing the many sociological complexities of this historic community. The map (or cartography) is a series of impressions in the form of an image seen from an extra-corporeal viewpoint-that is an opportunity for shared knowledge (Holmes 2006).

CARTOGRAPHY: MAPPING THE LAND, MAPPING THE CULTURE

One of the primary goals of this project was to create a repository of data that could demonstrate an evolution of the community and become a global forum for social interaction. The Virtual Embudo model deviated from our previous work in that *open platform* technologies would now be a primary component of the interface. The move to *open platform* emerged in a post evaluation of the VAP

project. From the community's perspective the main concern with the VAP was that it allowed for little interaction with the source data and many felt that the interface was counterproductive as a tool for social and cultural development.

The team understood these challenges and in researching open platform applications, a series of technologies began to emerge that would allow users to upload and interact with the data. Of particular interest was the use of Google Earth as a primary foundation, thus deviating from the GIS platform. GIS technologies can be problematic because information is difficult to manipulate, the interface is not user friendly and the static environment is not conducive to communal dissemination.

ORGANIZATION AND DATA COLLECTION

The primary visualization component centered on two data sets: the landscape in transformation, and the community in evolution. In establishing a documentation format, the research was divided into three major foci. The first was collecting information to support the creation of a Google Earth core. This included establishing the geographical reference point, inclusion of aerial imagery, topographic information and supported importing shape files. The second major form of data collection included establishing a bibliography, researching the literature relevant to the region, and collecting historical photographs available from various libraries throughout the state. The third initiative established a format for oral/video documentation, postproduction and video stream dissemination.



Figure 4: Google Earth Web Interface

FIELD METHODOLOGIES

The visualization data acquired early in the project was assembled to produce a virtual core structure for subsequent field research visits. Of critical importance to this research were ongoing conversations with key community members, including Estevan Arrellano, Katya Crawford, and Levi Romero, who identified assets that they felt were geographically and/or culturally important and thus warranted documentation. Understanding the political, cultural and environmental complexities within the community was a priority for all the site visits.

We began by assembling a team that would document the landscape photographically and utilize Global Positioning Systems to articulate placement in Google Earth. This was critical in defining the exact location of key built structures and the exact geographic location of the acequias. This data, which included latitude, longitudinal and elevation coordinates, was then imported directly into Google Earth and articulated in vector form to create a stand-alone 3-dimensional model in 3d Studio Max.

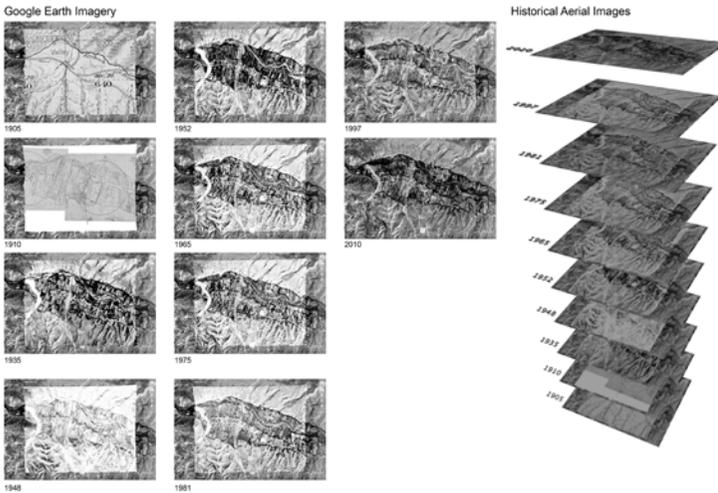


Figure 5: Historical Aerial Images , (T.B., 2011)

Photographic documentation was created in panoramic format to expand on the environmental immersive qualities of Google Earth. Each photograph was G.P.S. tagged to be geographically located and imported into the interactive interface. The Acequia del Llano and the Acequia de la Plaza were photographed in an animated series to demonstrate the relationship of the land to the water.

All video documentation was coordinated with community members to identify individuals who had been active in the Comision de Acequias. The format for the video documentation was organic in process to ensure that the conversation was genuine. The team made it a point to create a comfortable environment for each interview and allowed the individual(s) to choose the setting. The point in these conversations was to elicit memories that were shaped by the people, the landscape and the water. These documentary clips were then edited in post-production and uploaded to YouTube open platform for mass dissemination.

ARTICULATION OF THE DATA AND OPEN PLATFORM DISEMINATION

Disseminating selected material to a global environment became a project goal. While it was of primary importance to empower and assist the community of Embudo/Dixon, the team was also interested in allowing the cultural and historical evolution of this environment to be available to a broader audience. Research time was spent determining how best to utilize the Google technologies to disseminate and articulate the data.

The unique structure of Google technologies allowed us to create an interconnected data repository whose seamless interactivity enables navigation. Three major tools offered from the Google platform were primary to the development 1.) the use of Google Earth as a backbone for all layers, including all built environment 3-dimensional models, was established as the main interface 2.) the master model could then be linked to a Picasa photo archive to geospatially relate all photographic data and panoramic sets and 3.) all video documentation could be uploaded into the YouTube interface and linked to the master Google Earth model for specific location and data capture.

The flexibility of this interface allows community members and other participants of the digital environment to create subset information that may be linked to the master model. Open platform creates a new venue for historical and contemporary information to be developed thus promoting an organic growth of information that expands beyond the funded resources of this project.

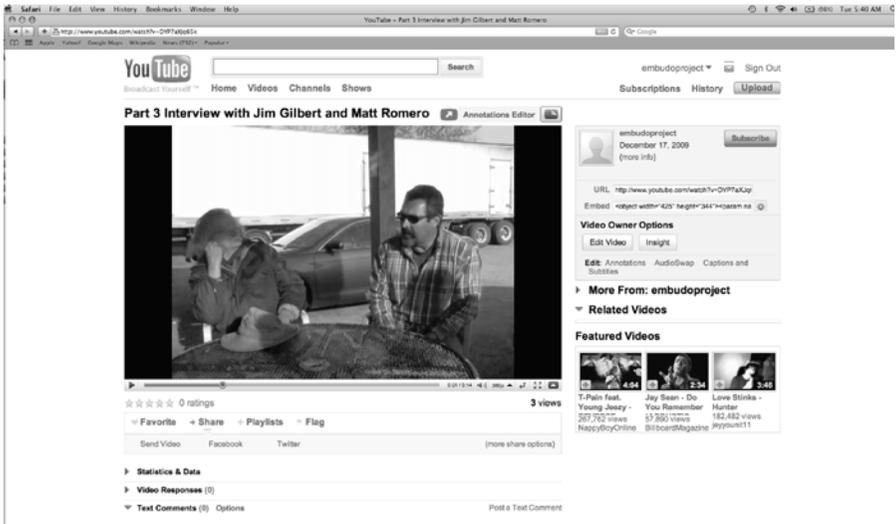


Figure 6: YouTube interview database

CONCLUSION

This model has great potential for documenting culture and historical evolution. The use of new media and technology allows for a more holistic understanding of “place”.

New Mexico is rich with historic communities whose socio-cultural history and built environments can be documented and preserved through a digital model that can migrate to an open source platform. We are interested in testing this model in other environments, thus challenging the team to understand how visual communication can be used to document cultural evolution and unique contexts. This is essential in testing the model’s transportability and capacity to serve, not only as a repository for community knowledge, but as an agent with which to sustainably shape rural environments and the actions of the community for generations to come.

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Education and architecture. Young people's perspectives and dialogues for a better understanding of built environment.

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ABSTRACT

This research aims to understand young people's prospects on the the spaces they inhabit and how these spaces affect their ways of living, through a qualitative ethnographic case study. An incorporation of knowledge from the disciplines of Architecture and Education is proposed, combining their relevance methodological, epistemological and social strategies in order to provide socio-educative strategies around and from architecture.

The ethnographic research is taking place in a school in Oporto's city center, with students from the 3rd cycle of basic education (7th to 9th grade, between approximately 12 and 15 years old) different research techniques are being used – participant-observation, semi-directive interviews and focus group discussion. The objective of this research is to understand the perceptions of young people about the built environment and how can they relate to it. Subsequently, through these perspectives, a global vision of architecture will be discussed and questioned, as well as, its social, economic and political potentials, considering young people as social actors and authors, clarifying how can they have an active role in improving building environment, using architecture as tool for citizen education.

In this article we present a preliminary analysis of focus group discussions that give us some clues for further research development. In this intermediate stage of research we can point to the existence of a direct relationship between the level of power over a given space and the satisfaction level, that is, the more young people appropriate spaces, the more they identify with them.

CONFERENCE THEME: "Integrating the human dimension in architectural research"

KEY WORDS: Architecture, society, education, citizenship, empowerment

"In a conversation with young people:

Researcher (R) - What do you think architecture is?

Participant 1 (P1) - The shape of everything, of how to build things.

(R) – What is it for?

(P1) - To build whatever we want.

(R) - And where does it exist?

(P1) - In all that surrounds us.

(R) – Would you like to learn more about architecture?

(P1) - Yes, to learn more about what surrounds us (...).

(R) - Why do you think architecture is important?

Participant 2 - To do the right things and in practical ways, do things with the exact measurements (...)"

In this small dialogue we can understand how conversations with young people are revealing; we see through this speech, a disarmingly objectivity thinking pattern. It is from them and from their speech that we intend to conduct our research, strengthening the communication between architecture and society and integrating the human dimension in architectural research.

The interest for subject arises from the architectural practice. The main author of this research, as an architect, finds some difficulties in communicating in different contexts and with different people about her work and its advantage to the quality of construction. This communication problem arises because of how architects' spatial conceptions are in part, distinct from the users' in that basic concerns are not focused on what is essential to architecture as a generator of stimulating spaces, that promote comfort [physical, emotional, social, thermal, mental.]. We think that a better perception of space in a user's perspective is essential to understanding the architectural social role and the kind

of dialogues that can be promoted for greater and mutual understanding. Our research with young people adopts the perspective that they are not only citizens “to be” but they already have knowledge and skills that allow them to be active and autonomous citizens. (Corsaro, 2005).

The need for this research also emerges from the current context of architecture in Portugal, within the diverse social economic, political and cultural perspectives, architecture, as multidisciplinary knowledge, provides dialogue among different disciplines. This relationship can be established in different ways, so we are interested in characterizing these dialogues and clarifying in which sense they are related to our issues. The “problem” is not specific to architecture, but across all these fields of knowledge and it is in this context that we intend to circumscribe the field of study of our research, establishing a bridge between architecture and education.

We start with an identified social problem: architecture is not understood by people in general as a vehicle for quality of life improvement in Portugal. There does not seem to exist an effective educational policy for citizens’ involvement in the built environment and their participation is scarce. Moreover, dialogue between architectural world and society has led, on one hand, to a weak understanding of “architectural culture”, and on the other hand, to a certain blindness or autism in relation to social experiences. **This dichotomy between architecture and society may be related to the fact that the “architectural world” is thought, to some extent, outside social reality and everyday existence, not being originated from the users but hypothetically constructing for them.**

The problem here identified can be translated in others: a low rate of participated architecture; a small involvement of citizens in built environment and territory, limited request of architectural work; a weak relationship between architecture and society, and incompatible languages between them. Part of these problems have origin in architects’ professional identity and status in that “weak readability of Architecture (poor rapport with the other disciplines) and the tendency for self-isolation; the instability of the different modes of exercise (i.e., the lack of formalization of roles and social responsibilities of the architect) (...)” (Brandão, 2006b: 218) are among the factors determining this crisis.

If we consider that “in the architect’s field the differentiation of the ways and levels of understanding and practicing the discipline itself is increasingly clearer, interdisciplinary is much more compelling as solutions to problems that arise appear less obvious at the starting point. Interdisciplinary is a response not only to the technical complexity but rather a requirement for making objectives of multiple levels (sometimes contradictory) compatible, and respond to the uncertainty that surrounds us” (Portas, 2006:12).

Thus, this study seeks to articulate architecture with the education in order to establish a new dialogue through interdisciplinary. For architecture it is important to work through the issues of architectural space through the user, and how he sees and appropriates the spaces, adapting and adjusting the design to the needs of the inhabitants.

For education it will be important to work personal and social relationships from the physical space, understanding how the built environment influences the way we learn and grasp the world around us. We will discuss the issues of power and ownership, the sense of belonging and identification with the spaces we inhabit, to better integrate the human dimension in architecture. We believe that knowledge sharing; resource optimization and discussion of the results may stimulate the mutual enrichment of both knowledges, promoting social and educational strategies around and from architecture, allowing the empowerment of citizens.

For architecture the space is the result, building is to create and conform new spaces. These spaces may have different physical characteristics, being tall, short, wide, narrow, bright, articulate, functional, modelers, etc., or may be predominantly social characteristics: sensory, neutral, inhabited, public, private, hierarchical, appropriate, modeled, organized, educational, isolated, insulated, etc... In both situations it is the human being who has the perception of these spaces and gives them certain characteristics, identities and subjectivities. “The body is connected to a place for a direct link, a contact, which is but one way among others to relate into the world.” (Bourdieu, 1998a: 120). Architecture works with the physical dimension but also with the social dimension, thinking the space

as a whole, space of living, being, interacting, memory, culture, learning, time, body, relationships, communication, identities, life experiences, and interactions.

These space readings are what we want to know and to understand; which are the spatial subjectivities of young people and what are the relationships they establish with certain areas. "Subjectivity refers to "the space of representation itself, but also the place where the individual is aware that there are representations and, therefore, is distanced from the world (Martuccelli, 2002: 442)" (Silva, 2008 : 22). The relationship between the subject and the space where he belongs has different influences, which confer a certain subjectivity. The space is built by humans, but it is also the space that conditions and models, there is an ongoing relationship that gives us our space identity. The interpretation that each individual makes is directly related to the spaces they inhabit, but also with their standpoints (Harding, 2004). The question of pertaining to a place is inseparable from the question of identity and how they are subjectively defined by showing how groups and individuals relate to the area, seizing it and also being defined by it (Silva, 2008). It is in the physical space that the real and symbolical distinctions of social space are expressed (Bourdieu, 1998a; Lopes, 1997).

According to Foucault (1988), spaces have certain characteristics that affect us, this is the question of body disciplining in terms of the space we inhabit, in the sense that it affects us and normalizes our actions. But in which way young people feel these constraints today? What kind of relationship do they have with space and until where goes their freedom to use it? These and other issues relate spaces with subjects' actions in specific places that we would like to see decoded in order to better understand the inherent subjectivity.

The architecture of schools is definitely the privileged space where we work on "Education in Architecture". The spaces are designed to teach, ranking the different levels of concentration and study. In addition to focusing on the main school space, the classroom, the space of formal education par excellence, it is important to understand how the school functions as a whole and how the remaining spaces are also educational. The school program has been monitoring educational needs. At the moment, school is not only the classrooms and access corridors but a multiplicity of spaces suitable for different school experiences.

On the other hand, we think the theme of education in architecture in a broader perspective in order to understand the genesis of space around us and how it influences our daily life, stressing the importance of built space in the development of our relational skills.

The choice of a school to achieve this ethnographic study relates to the fact that is a specific context where young people spend most of their days. School is the main environment where young people socialize, where they spend the time required for the classes and also some of their leisure time. From this context, where we can find children and young people, we can have privileged access to interactions and behaviors that would not exist in other places. School is not a simple building but it is composed of different types of spaces with un equal, and not always obvious, levels of privacy, which allow different types of readings, appropriations and occupations.

To choose the school in which to conduct the investigation we took into account five main factors: a school included in "*Parque escolar*" program, located in the city of Oporto ,with Primary and Secondary education, and easy person contact and access .

The school in which we are conducting this qualitative research is the Primary and Secondary School Rodrigues de Freitas, a school in Oporto's city centre, located in the urban area and close to the historic center. The fact that it is between two distinct areas of the city, among the oldest area [Cedofeita] and the most modern [Boavista] leads to greater cultural diversity. The original project of the school is from the architect Marques da Silva, built between 1927 and 1933, the year that it was inaugurated, although there were still construction works until 1939. Between 1956 and 1958, the building underwent an expansion and renovation project by the architect Fernandes de Sá. Recently, the school has been part of the project for modernization of schools "Parque Escolar" as a pilot school - project by the architect Manuel Fernandes de Sá – and it was completed in 2008.

This framework allows us to understand a part of the socio-historical context of this building: from the former school for boys to the Rodrigues de Freitas of today, how the structure and the architecture remain and the spaces are reinvented, and the readings that its users do of the "before" and "after".

This renovated building also has the particularity of reconciling two schools in the same building: the Rodrigues de Freitas school and the music conservatory of Oporto which share some infrastructures but whose privileges are not completely comparable because the students of the conservatory are allowed in the spaces of Rodrigues de Freitas but the reverse is prohibited.

Schools are places where the formal participation of young people in the organization of space is not significant. However, they often subvert the spaces as their own and appropriate them. Our goal, in addition to finding out what they think about the spaces and working these issues with them, is to understand how, in their own way, they participate in the organization of space even if this mode of participation is not recognized. We intend to give visibility to these forms of involvement and participation that are perceived as smaller, less worthy, and in some cases, even deviant. It will be essential to pay attention to their speech and behavior. We will assume responsibility for listening to and understanding their relationship with space, the city school, and also to hear their proposals. By understanding their practical reasoning we can better understand what is meaningful to them in their relations with the spaces and this is a way to be able to think about more refined strategies on how to promote such a dialogue between architecture, education and citizenship.

In our investigation, education will be the mean by which the architecture will be worked on and explored. We will begin by exploring young people's knowledge about the spaces and architecture that surround them, trying to understand their spatial perceptions, how they relate to space and how it is appropriated. From this awareness we will develop a critical-constructive perspective in order for them to be able to suggest improvements and new ways of appropriating space, always from the user's perspective.

This will be a qualitative investigation in which we do not go into the field with previously formulated hypotheses. We have, however, an observation field within certain limits in which young people interact, and where we seek to understand how they relate to the school and what kind of experiences emerge.

In qualitative research, researchers "(...) tend to analyze their data inductively. They do not collect data or evidence in order to confirm or refute hypotheses constructed previously, rather, abstractions are built as the data individuals that were collected will be gathering." (Bogdan, Biklen 1994:50). This process is unclear, the observed fact leads us to another and so on, it is around this story that we build our arguments, but without ever moving away from our empirical object.

Although this methodology is common in education, it is not widely used in Architectural research. However, as our research evolves, we find a great empathy between architecture and qualitative investigation, especially as in this case we are interested in knowing how young people relate to space/architecture and which are their interpretations and understandings. The ethnographic method integrated with a qualitative research allows us to have a perspective of built space from its actors and authors, trying to see with their eyes the reality that surrounds them. This methodology allows architecture to be directly in the hands of who enjoys it more directly, and will use and appropriate spaces, and also who will give them meaning and identity. It is an opportunity to look at the architecture project beyond the construction stage, and beyond the so-called late stage, which is actually the beginning of another phase that is not less important, the habitation of space as the scene of action, scenes and experiences which confer it meaning. This step is where we can really evaluate the architecture and see if it corresponds to the tasks that were initially set, listening to those who inhabit the space and relate to it. Moreover, it is through this assessment that architecture can reflect on its design process and challenge new forms, new spaces, new construction, combining the knowledge of the architect with the experience of the user.

Following these assumptions and guidelines, our investigation will use various research techniques: participant observation, semi-structured interviews and focus group discussions. "(...) Here, again, we are focused on research strategies that allow the researcher to grasp the social world at first hand." (Burgess, 1997:3). This diversification of research methods allows us to absorb different perspectives within the same context. This theme of "multiple strategies", "(...) allows the investigator to use a certain variety of methods, data, research and theories in the context of any study, thereby overcoming problems such as bias. However, when using this term we have another purpose: not

only to see different approaches used simultaneously, but to see them integrated in ongoing research (see Zelditch 1962, Sieber, 1973). "(Burgess, 1997:160).

The chosen methodology will be an ethnographic case study. What is ethnography for us? Most important, it is a family of methods involving direct and sustained social contact with agents and of richly writing up the encounter, respecting, recording, representing at least partly in its own terms the irreducibility of human experience. Ethnography is the disciplined and deliberate witness-cum-recording of human events. (Willis, Trondman, 2000:394)

According to the Manifesto for Ethnography *An interest in cultural policy and cultural politics*. We must explore the role of critical ethnography in developing conscious and evocative policy forms that help to make explicit embedded logics, so that social actors become more agents of their own will but within some sociological frame, somehow understood, conditioning and setting its limits of possibility—changing the social within the social (Willis, Trondman, 2000)

Through the ethnographic method we can meet the cultural and social practices that are visible in everyday life, without changing them, we can understand the views of social actors and fit them in their context.

Initially, through participant observation we will notice how young people relate to space, how they appropriate it. Hence, we intend to perceive the meanings assigned to each of the spaces and to what extent they represent synonyms of individual and social identities. In the second phase we will work specifically with young people in the 3rd cycle (from 12 to 15 years old), performing Focused Discussion Groups, trying to listen to them and identify the types of readings that they have of spaces, as well as asking them about the kind of power they feel they have in the areas they inhabit. This discussion is important, not only to motivate them to act but also to question them and make them feel responsible for preserving the spaces that surround them. They can understand how architecture can be a vehicle for the improvement of living conditions and through which they can their spatial needs.

Given that the school where we are conducting our research is included in the "Parque Escolar" program and was recently renewed, we will perform some semi-directive interviews so as to understand the perspectives of different actors of the school environment on architecture and design. From this data platform, we will then launch new guidelines for the development of our research. The interviews work as a complement to the research process and participants will include the project architect, mentor, and at least one teacher, one student and one employee who were in school before, during and after the works performed. With this kind of approach we aim to understand the meanings and interpretations that users have of the spaces they inhabit and also realize the architect's sensitivity and experience regarding this process.

In interviewing the architect responsible for the renovation of the school we can counteract his expectations of the project with the type of ownership and readings from young people who inhabit it, thus providing a double reflection of the architectural object, i.e., performing the Post Occupancy evaluation which included the impact of the built environment on its inhabitants.

At the end of this investigation we hope to be able to understand to what extent the space we live in influences our way of being and relating with each other, thereby having a complete picture about the importance of integrating the human dimension in architectural design. We seek to reconcile the prospect of citizens with the architects in order to stimulate synergies in both directions and provide greater dialogue, cooperation and involvement. Based on existing work with young people, particularly during participant observation and focused discussion groups, we will now present some thoughts and conclusions that we reached, particularly with regard to youth perspectives on school spaces and their sense of ownership and power of those spaces. Field notes are the most significant part of our empirical material and correspond to the ethnographic work, where we note the field work and data collected. It is from them that we will perform content analysis and research base, thus the quality of field notes affects the entire investigation. Content analysis corresponds to the data collected during the ethnographic research, field notes, in this case on participant observation and focused discussion groups. This type of analysis is concerned primarily with the text content and its empirical conditions.

While performing content analysis on the data, we will classify the descriptive data collected according to the issues and concerns raised by the investigation. After a first analysis of data collected during participant observation, we drafted the scripts for the focused discussion groups. Despite not being specific categories of analysis, we identified different areas of development work. Starting from a global sphere to the personal scale the identified areas are:

- The School - Rodrigues de Freitas,
- The common areas of the school,
- The classrooms and corridors
- “Our” spaces
- The school and conservatory - socio-spatial relations
- Sense of ownership / change of space
- The school and the city
- From home to school
- House
- My spaces
- Dream spaces

Across these themes we always worked to identify young people’s dimensions and the personal relationships that are always inherent.

In this article we present some of the findings, mainly related to the first five identified topics.

When questioned about the spaces that they like best at school, young people give preference, in general, to recreation and leisure at the expense of spaces for formal education, the classrooms. Even in the distinction between classrooms, they prefer some over others, not because they are spatially different, but mainly because of the type of subjects and activities that are developed there. Thus, they associate the degree of satisfaction with the space with the activity that is developed there and the experiences that they have in this particular space.

Regarding outdoor spaces there are also unanimous opinions: the playing fields and outdoor recreational areas are preferred. When referring the outdoor spaces associated with the conservatory to which students of Rodrigues de Freitas do not have access, initially they say they do not like it, but when we try to understand why they do not like it, their answers are evasive and not specific enough. We infer, from their speech, that they dislike the spaces not for their conformation but because they are out of bounds. Eventually, they confess that they have already been in those spaces, and used them occasionally, but their stay was forbidden, hence the main reason for disliking them.

Although there is no physical separation between Rodrigues de Freitas School and outer spaces of the Conservatory, the youngsters know exactly how far they can go and can clearly define the borders, thus contradicting the physical space to social space. When we refer the relationship between buildings and their separations, they become physical and are clearly identified. However, there is still the possibility of some visual communication because the doors, even though locked, are in glass and allow viewing of both spaces. This relationship between the two schools is interesting because although the physical spaces are similar, the way of being in them and the sense of ownership is very different. Conservatory students usually occupy the living space, with chairs and tables they can use to work in groups and study. Rodrigues students do not have furniture and only have transit areas, where they are just talking or standing while waiting for the bell to ring.

Another important factor that helps us understand how young people occupy school space has to do with the degree of freedom and privacy they have in each of the spaces. The more the space is hidden; hence less guarded, the more they privacy. They talk about these areas in an emotional way, giving them names that only they can identify, like they were secret spaces that are accessible but do not have permanent circulation. Another fact that must be taken into account is that in this school there is a large difference in the ages of the oldest (18/20 years) to the youngest (10 years). Depending on the ages and hobbies, young people occupy certain spaces over others. For example, 8th grade students (13/14 years old) speak of the entry space as if they did not like it – it is just for passing through. They

associate it to the fact that it is by the entry that you come to school, and because they do not like school, they do not like the entry. This space is typically used by older students that, being prohibited to smoke at school, are concentrated at the entrance outside. When asked if they really do not like school, they say that they do not like to come but after being there they like it.

In this intermediate stage of research we can point to the existence of a direct relationship between the level of power over a given space and the degree of satisfaction with that area, that is, the more young people feel the spaces as theirs, the more they can appropriate it, the more they like it because they identify it with themselves.

These living spaces can be individual but also social, as Marc Augé mentions, “the spatial device simultaneously expresses the identity of the group (the group’s origins are often different, but it is the identity of the place that establishes, gathers and unites it)” (Augé, 2005:41). It is in certain areas that relationships happen, where we meet, cross and live. In a second phase of the investigation we will attempt to understand how these spaces affect the way of being, as well as what kind of alterations and changes young people want to see in the spaces in order to increase their enjoyment in inhabiting them.

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Measuring sustainable homes - a Mixed Methods approach

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ABSTRACT:

The paper studies the *Active House vision* and the *Active House Specification* work-in-progress to identify what parameters to measure when measuring sustainable homes of the future. The approach is based on a Mixed Methods research strategy where measurements are related to both quantitative and qualitative aspects in relation to the categories Energy, Indoor climate and Environment. The *what to measure* part of the paper results in a matrix that lists the measurement parameters. On basis of the measurement parameters a set of methods are compiled into a matrix that defines *how to measure* regarding quantitative and qualitative aspects. These methods imply Logging and data handling in Excel, Luminance mapping, Cultural Probes, Semi-structured Interviews, Observation, Self-experience studies and photo registration. The paper presents two matrices on *what* and *how* to measure sustainable homes. The paper is concluded with the assumption that exploring seven experimental sustainable homes will result in knowledge and learning to develop a holistic assessment method for evaluation sustainable homes of the future.

CONFERENCE THEME: On Measurement

KEYWORDS: Measuring, sustainable, homes, Mixed Methods

I. INTRODUCTION

Focus on development of sustainable architecture is at an ever high. This has resulted in eagerness to prove the performance of buildings resulting in an increase of rules, evaluation criteria and legislation bringing the tendency of gradually overlooking qualitative aspects while focusing on the quantitative and immediately measurable aspects (Birgisdottir 2010). The tendencies bear witness to a paradigm shift in the ways of considering and studying sustainable living and sustainable homes – a tendency indicated by several recent research projects (e.g. Marsh et al 2010, Entwistle 2010, Brunsgaard 2011). According to Willars and Lynch (2010) the technical means only account for about 20 percent of solving the challenges, whereas occupants' behaviour and lifestyle can account for at about 80 percent. This underlines the importance of not ignoring the architectural and qualitative aspects related to experience, well-being and health and appoints to an approach based on occupants' needs and experiences.

With the new strategic initiative *Active House vision* attention is brought to a holistic approach to considering and developing sustainable homes of the future (Sloth 2010). The initiative is based on collaboration between the building industries, product companies and research institutions and carries the objective to create knowledge that develops holistic sustainable architectural solutions of the future.

The *Active House vision* has resulted in the development of a full scale experimental lab consisting of seven sustainable homes. This project makes it possible to measure these seven experiments through exploratory research in contemporary issues related to the paradigm shift providing possibility of qualitative estimates for developing sustainable homes.

The main objective of the work is to design *a method for holistic evaluation of sustainable homes of the future*. The inclination to establish a holistic assessment method is to provide for a more balanced consideration when learning how to design and develop buildings of the future. Quantitative aspects typically represent the physical and technical – whereas qualitative aspects typically represent the social, psychological and philosophical environments surrounding us.

Based on systematic research the compilation of an evaluation method, that can substantiate and demonstrate a range of sustainable aspects, should lead to the composition of evidence supporting the need to consider buildings from a holistic perspective. Evidence can influence political debate and decision-making and thereby push for implementation of *both quantitative and qualitative* aspects in future strategies, evaluation models and legislation.

This paper addresses the problem of *what* and *how* we shall measure sustainable homes to extract knowledge with which to aim for a holistic approach of assessment.

2. WHAT TO MEASURE IN SUSTAINABLE HOMES?

The purpose of the paper is to identify *what to measure* in order to compile data and information through measurement. Data and information is a necessity in order to analyze and identify *what parameters* are central to measure and evaluate. This implies the need for identification of *what methods* to use for measuring quantitative and qualitative aspects of sustainable homes. Through this paper we seek to verify what to measure through formulating the hypothesis that: *Through studies of the Active House vision and its coherent design parameters we can identify what to measure through quantitative and qualitative aspects.*

Identification of what to measure will lead to the problem of *how to measure* the parameters. This paper attempts to verify the hypothesis that: *By compilation of methods from natural science and artistic and humanistic disciplines it is possible to design a frame on how to measure quantities and qualities in sustainable homes.*

To approach verification of the hypotheses this paper will study state-of-the-art research projects that work with measuring sustainable houses. The projects take a Mixed Methods perspective on working with interdisciplinary set ups and in cross disciplinary fields in order to identify and measure quantitative and/or qualitative aspects (Bryman 2006).

Social science and anthropology explore social and behavioral environments through methods that build on empirical and bodily experiences and observations. The purpose is to identify and explore acknowledged and unacknowledged needs and desires. Methods include for instance observation, interviews and cultural probes. The recently conducted research project *Minimum Configuration Home Automation (MCHA)* about user driven innovation for developing minimum configuration products for home automation, partly rely on methods from anthropological science (MCHA 2009). Observation, semi-structured interviews and scenario studies have uncovered behavioral patterns in the occupants' everyday habits that proved to have great impact on environmental considerations. The research showed that non-verbalized and inherent habits carry a great responsibility for the 'hidden' energy consumption (Entwistle 2010). The habits were central to uncover to implement that knowledge into developing new projects based on the needs of the occupants.

Qualitative and quantitative research methods are also used in another recently conducted Danish research project regarding the *Comfort Houses in Vejle*, Denmark (Brunsgaard 2011). Ten passive houses and their occupants are subjects to measurements. Semi-structured Interviews (Kvale 2009) was used to systematically uncover the occupants' everyday lives and experience in the low-energy house. Simultaneously interviewing the occupants, measurements on energy consumption and indoor climate conditions was conducted. The project shows that occupant behavior in a low-energy house carry a considerable impact on energy consumption. (Brunsgaard et al 2010)

2.1 ACTIVE HOUSEVISION

The sustainable homes that compile the experimental setup for the project are developed from the Active House vision – a vision of:

(...) buildings that create healthier and more comfortable lives for their occupants without negative impact on the climate – moving us towards a cleaner, healthier and safer world. (Sloth 2010)

The vision defines three central categories: *Energy, Indoor climate and Environment*. *Energy - Contributes positively to the energy balance of the building*. An Active House is energy efficient and all energy needed is supplied by renewable energy sources integrated in the building or from the nearby collective energy system and electricity grid. *Indoor climate - Creates a healthier and more comfortable life for the occupants*. An Active House creates healthier and more comfortable indoor conditions for the occupants and the building ensures a generous supply of daylight and fresh air. Materials used have a positive impact on comfort and indoor climate. *Environment - Has a positive impact on the environment*. An Active House interacts positively with the environment by means of an optimized relationship with the local context, focused use of resources, and on its overall environmental impact throughout its life cycle.

An integrated intelligent controlling system constantly monitors and adjusts the indoor climate in accordance with occupants' needs and pre-set comfort demands. The *Active House vision* attempts to achieve balance between the environment, house and occupants (Sloth 2010).

2.2 ACTIVE HOUSE SPECIFICATIONS

The work of establishing the *Active House vision* has led to a *work-in-progress Active House Specification*. The purpose of formulating a specification is to make the vision approachable and designing-tools available. This supports moving further towards the vision. (Eriksen et al 2011)

The specification state a number of parameters belonging to quantitative and qualitative fields. In keeping with the vision it is structured by the three categories *Energy, Indoor climate and Environment*, also stating that:

An Active House is evaluated on the basis of the interaction between energy consumption, indoor climate conditions and impact on the environment.

The parameters are listed in *Table 1* under each of the categories and will form the basis of what to measure.

Energy

The category implies the groupings *Energy Design, Natural Design Solutions and Renewable Energy*. There seem to be a gap in elaboration of the quantitative and qualitative categories as the latter is hardly elaborated on. Only *design* and *comfort* are stated as parameters in the qualitative category and readings into the further definitions refer to the indoor climate category. Is it possible to state more elaborated qualitative parameters within *energy*? An approach to identifying qualitative aspects could be to relate to the values, occupants ascribe to energy; consciousness of using energy, contributing to reduction of global warming, awareness of consumption, and attitude towards producing energy.

Indoor climate

The category implies the groupings *Light, Thermal environment, Indoor air quality and Acoustics*. This category appears to be the furthest elaborated with very specific groups and units. The category is quite approachable regarding both quantitative and qualitative aspects as the problems rely on a bodily encounter – one of physical nature and one of experiential nature. It might be problematic that the very specific parameters could call for very specific measurement methods.

Environment

The category implies the groupings *Resources and emission and Characteristics and culture*. The parameters elaborated from only one perspective each making it difficult to see through the holistic approach to the category. The real-life-scaled project carries good odds of resulting in knowledge that can further elaborate the categories due to the contextual preconditions and its geographic extend.

The differences in degree of description and elaboration of the parameters clearly signal the *work-in-progress* stage of the work. However, the stated parameters will form the basis for *what to measure* in this *initial* part of the process of measuring with implied development.

	Energy	Indoor Climate	Environment (surroundings)
QUANTITATIVE	<p><i>Energy design/Type of energy:</i></p> <ul style="list-style-type: none"> • Space heating • Water heating • Ventilation • Cooling and air conditioning • Electricity for tech. installations • Electricity for lightning • Electricity for appliances <p><i>Natural design solutions:</i></p> <ul style="list-style-type: none"> • Passive solar energy • Daylight utilisation • Natural ventilation • Shading during cooling season • Integrated solutions • User behaviour <p><i>Renewable energy:</i></p> <ul style="list-style-type: none"> • Energy demand • Energy supply • Source of renewable energy 	<p><i>Light:</i></p> <ul style="list-style-type: none"> • Daylight • Direct sunlight availability • Surface reflectance <p><i>Thermal environment:</i></p> <ul style="list-style-type: none"> • Maximum operative temperature • Minimum operative temperature • Adjustability (individual control) <p><i>Indoor air quality:</i></p> <ul style="list-style-type: none"> • Air change • Minimum air change <p><i>Acoustics:</i></p> <ul style="list-style-type: none"> • Limit value for inside system noise 	<p><i>Resources and emission:</i></p> <ul style="list-style-type: none"> • Re-use of materials • Minimized use of virgin non-renewable materials • Minimized use of non-renewable fuel resources • Minimize life-cycle emissions of greenhouse gasses <p><i>Characteristics and culture:</i></p> <ul style="list-style-type: none"> • To be defined in future process
QUALITATIVE	<p><i>Energy design:</i></p> <ul style="list-style-type: none"> • Design • Comfort <p><i>Natural design solutions:</i></p> <ul style="list-style-type: none"> • Design • Comfort <p><i>Renewable energy:</i></p> <ul style="list-style-type: none"> • Design 	<p><i>Light:</i></p> <ul style="list-style-type: none"> • View out • Visual privacy • Visual comfort • Individual control • Dark bedrooms at night <p><i>Thermal environment:</i></p> <ul style="list-style-type: none"> • An intuitive human interface • Draught • Natural ventilation paths <p><i>Indoor air quality:</i></p> <ul style="list-style-type: none"> • Individual control • Low-emitting building materials <p><i>Acoustics:</i></p> <ul style="list-style-type: none"> • Acoustic privacy and quietness 	<p><i>Resources and emission:</i></p> <ul style="list-style-type: none"> • To be defined in future process <p><i>Characteristics and culture:</i></p> <ul style="list-style-type: none"> • Regional building typology • Regional functional tradition • Potentials and constrains in local climate • Regional materials • Harmoniously fit in landscape • Impact on street- and landscapes • EIA • Preservation of existing values • Ecological quality of the site • Risks by climate changes

Table 1: What Parameters Matrix: The categories Energy, Indoor climate and Environment in respectively the quantitative and qualitative approach. Source: (Authors' production based on the Active House Specification (Eriksen et al 2011))



Home for Life, 2009,
Lystrup, Denmark
New single-family house
190m²
Picture: Adam Mørk



Solar Aktivhaus, 2009
Kraig, Austria
New single-family house
150m²
Picture: Gitte Gylling



Haus der Zukunft, 2009
Regensburg, Germany
New single-family house
175 m²
Picture: Gitte Gylling



Licht Aktivhaus, 2010
Hamburg, Austria
Renovated double house
More information later...
Picture: VELUX



Sunlighthouse, 2010
Pressbaum, Austria
New single-family house
Picture: Adam Mørk



Carbon Lighthomes,
Rothwell,
United Kingdom
New double house
Picture: VELUX



Maison Air et Lumière,
Varrières-le-Buisson,
France
New single-family house
Picture: VELUX

Figure 1: Seven experimental houses designed and built according to the Active House vision. Source: Authors design.

2.3. EXPERIMENTAL SETUP

To investigate if the proposed measurement parameters are legitimate and to explore errors or absence of aspects we will measure these parameters in a full scale experiment of seven sustainable homes. The seven experimental houses are designed and constructed according to the *Active House vision* as single-family-houses of which one is a renovation project and the remaining are newly built. The houses are geographically located across Europe, with two houses in respectively Germany and Austria, while one house is built in respectively Denmark, France and Britain. This geographic extent provides an interesting basis for studies on energy optimization and importance of place and location to the experience of each house, as well as to the strengths, weaknesses and comparability of houses. Each house has distinctive characters, as they are built, taking into account local, cultural and climatic conditions and with different teams of architects, engineers and contractors. The overall perspective focuses on combining an aesthetic energy-design, high comfort and good indoor climate - while resulting in minimal environmental impacts (Hansen 2010).

When the houses are built and adjusted, families move in for a one year period to test and experience living in and with the houses. First three houses will be tested to the measurement parameters and outcomes will be analyzed. The analysis will be evaluated to analyze whether the parameters provide us with a holistic illustration of the homes and to analyze what can be enhanced regarding parameters, approach and methods. Subsequent, measurements of the remaining four homes will test and revise the model to verify it. Each house will be treated as a case study in an embedded multiple-case design (Yin 2009).

The objective is to test if the measurement parameters can help provide the required answers to the questions and help verify the stated hypotheses.

3. HOW TO MEASURE SUSTAINABLE HOMES?

To be able to measure the identified parameters in the seven experimental, sustainable homes an identification of *how to measure* these is required. Studies of state-of-the-art research projects' use of methods from natural sciences and artistic and social sciences will inspire and support choice and compilation of methods.

How do we measure a house by its ability to improve life to its occupants? As the sustainable homes are designed from a holistic perspective measuring will similarly be approached from a cross scientific and Mixed Methods perspective, by introducing both methods from natural sciences and artistic and humanistic disciplines. Qualitative and quantitative research is often presented as two fundamentally different paradigms through which we study the social world. Through a Mixed Methods Research strategy quantitative and qualitative data are brought together to provide for comprehensive collection

and analysis corresponding to holistic hybrid view on sustainability and measuring (Bryman 2006).

Mixed Methods Research (...) an approach to professional research that combines the collection and analysis of quantitative and qualitative data. (Creswell 2009)

The Mixed Methods strategy is carried out as sequential practices where research into quantitative data is followed by research applying qualitative methods to the data. The approach can also be performed vice versa and as an iterative method. For instance measurements on quantitative data can reveal fluctuation, and to explain or explore this, qualitative methods such as interviews or observations can identify details or tendencies in e.g. user behaviour (Creswell 2009).

Both quantitative and qualitative data are considered to represent aspects of the relations between occupant, house and environment, which will also be reflected in the choice of methods to study these.

3.1. MEASURING QUANTITATIVE DATA

The intelligent controlling system implemented in the design of the homes is appropriate to use for logging data. The system monitors weather and indoor climate to adjust the house to the occupants' needs. Meters are placed on the system that can log and extract data on energy consumption and production, related to respectively heating and electricity, on weather and physical and behavioral indoor climate. Manual measurements on daylight can support investigations on the indoor climate light parameters, which are the most widely elaborated in the specification and daylight appear as a focal aspect in the *Active House vision* (Hansen 2010)(Osterhaus 2010)(Førland-Larsen 2009).

3.2. MEASURING QUALITATIVE DATA

Studies of the MCHA and Comfort Houses projects show that several qualitative methods can be used for studying the relations between environment, home and occupant, as e.g. observation studies, interviews or scenario-observation studies. This leads to wondering, if a triangulation of methods can support a more holistic perspective on measuring qualitative aspects?

In the studied research projects that treat experiences related to sustainable living, there seem to appear three perspectives to filtering these experiences; a private, an inter-relational and a professional (Søndergaard and Entwistle 2009) (Brunsgaard 2011). Inspired by this three-way perspective and a triangulation of methods a three-parted structure is suggested to build the qualitative research setup on.

Occupants' experiences

How can we measure occupants' experience of living in the house when we are not present? Differences between the occupants' acknowledged and unacknowledged needs and experiences of living in and with the houses are a central offset for measuring qualitative aspects. The occupants' experiences imply perspective on living in the house, why this method attempts to document experiences through the occupant's perspective. User based exploration focus on how the occupant experience life in a sustainable home and interrelations and inter-influences between occupant, house and environment have an effect on perceptions and feelings with regards to living in an intelligent and sustainable house. Registration of user experiences is based on *Cultural Probe* method. This imply that the occupant is set the task of registering data from experiences of living in the house through photos (digital camera), a log book for noting immediate thoughts (physical note book), and a diary (electronic template) (Bryman 2008) (Hastrup 2003).

Interviews

Interview is a frequently used method to gather data. The method appears in several research projects as the user perspective is gaining importance (Brunsgaard 2011) (Entwistle 2010). A qualitative interview can be based on several approaches. Inspired from the MCHA and Comfort Houses projects the *Semi-structured Life-world Interview* will be used; a method appropriate for extracting knowledge from and understanding the life-world of the interviewee (Kvale 2009). The flow of a

Semi-structured Interview creates possibilities of sudden new questions to explore appeared subjects of interest or to navigate away from such if these are off key. New insight and knowledge might appear from unexpected sides that might come to be relevant to the research. The face to face interviews will be done in the sustainable home, establishing a safe setting. An appropriately tailored interview-guide forms the overall framework for the interview situation consisting of questions and sub questions relating to different themes (Kvale 2009). The method help create knowledge about the experiences the occupant is able to verbalize. Also, the conversation about the occupant's everyday experiences of living in the house might result in new recognitions to the occupant. (Kvale 2009)

Self experience studies

The experience studies based on architectural theory and phenomenology are central when dealing with the hybrids between bodily and special experience. The MCHA and Comfort Houses projects does not deeply deal with this approach though considering the research approaches from more divisible perspectives. Professional knowledge about architecture is considered central to connect the different methods. First-hand empirical field study experiences can provide for an enhanced possibility of connecting the dots between occupants' behavior and statements related to the technical functioning of the house. The experience registrations are based on architectural methods, phenomenology and sensing approach, inspired by Juhani Pallasmaa (2005, 2007), Steen Eiler-Rasmussen (1989), Louis Kahn (Lobell 2008), Dean Hawkes (2008) and Peter Zumthor (2006). Registrations will be compiled in descriptive and narrative texts supported by photos.

4. RESULTS

Below, the results of studies in *how to measure* are presented in a matrix. The methods are presented in relation to the categories to undergo research with the intent that the proposed methods can support finding answers to the measurement parameters. This concluding matrix should be understood as framing the proposed methods in relation to investigating the identified measurement parameters. This matrix further relates to measuring the first round of sustainable homes and thereby reflects its initial stage.

Quantitative measurements are listed as reasonably specific and are expectedly plain sailing. Qualitative measurement parameters and methods appear more indistinct and blended and expectedly it will be challenging to relate to a specific category due to an experience that experience is complex to classify.

5. DISCUSSION

5.1. ON THE ISSUE OF MEASURING

When looking into the concept of measuring in relation to buildings and architecture a lot seems to rely on quantitative means. Are the qualitative aspects of a building not considered as important to prove as the quantitative ones? Or is it simply not possible to put a formula to quality?

Qualitative aspects can immediately appear quite intangible since they rely on feelings and experiences rather than numbers. The line of thought appoints to the tangible difference inherited in respectively the quantitative and the qualitative aspects of sustainable architecture and thereby it appoints to the still stubborn persistently existing barrier between engineering and architecture disciplines.

“I only wish that the first really worthwhile discovery of science would be that it recognized that the unmeasurable is what they're really fighting to understand, and that the measurable is only the servant of the unmeasurable; that everything that man makes must be fundamentally unmeasurable.” – Louis Kahn

In the above quotation by Louis Kahn seem to capture the essence of the tangibility of the quantative and qualitative. Opposed to the conventional upbringing within sustainable architecture he points to the unmeasurable – qualitative – as the fundamental aspect. Is Kahn right in his statement? Would the quantitative aspects loose their justification without their dependence on qualitative aspects? Hopefully, the studies can bring us closer to answering these wonderings.

	Energy	Indoor Climate	Environment (surroundings)
QUANTITATIVE	<p>Meters are placed on energy consuming and producing devices. Data are logged as mean hourly values.</p> <p>Logging:</p> <ul style="list-style-type: none"> Heating consumption: <ul style="list-style-type: none"> Space heating (kWh/m²/mth) Water heating (kWh/m²/mth) Electricity consumption: <ul style="list-style-type: none"> Ventilation (kWh/m²/mth) Cooling/air con. (kWh/m²/mth) Electricity for technical installations, lightning, appliances (kWh/m²/mth) <p>Natural design solutions:</p> <ul style="list-style-type: none"> Passive solar energy: Indirect evaluation as by energy savings Daylight utilisation: Lux + electricity Natural ventilation: Indirect eval. Shading during cooling season integrated solutions measured by logging data in awning position. User behaviour measured through collection of super steering of system and presence data <p>Renewable energy:</p> <ul style="list-style-type: none"> Heating production (kWh/m²/mth) Electricity production (kWh/m²/mth) 	<p>House is separated into zones (rooms/areas) constantly measured. Meters placed on walls 1.6 m above floor in shadow. Data are logged as mean hourly values</p> <p>Light:</p> <ul style="list-style-type: none"> Lux data are logged (lx) TimeLapse Luminance mapping/pictures () <p>Thermal environment:</p> <ul style="list-style-type: none"> Temperature data are logged (°C) <p>Indoor air quality:</p> <ul style="list-style-type: none"> CO₂ data are logged as mean hourly values (ppm) Relative Humidity data are logged as mean hourly values (%) <p>Acoustics:</p> <ul style="list-style-type: none"> Observation of the acoustic environment will help determine whether measurements of the acoustic environment in and around the house are required 	<p>Logging weather data – meters are placed on roof top constantly measuring. Data are logged as mean hourly values.</p> <p>Weather:</p> <ul style="list-style-type: none"> Outdoor temperature (°C) Outdoor lux (lx) Rain (1/0) Wind speed (m/s) <p>Resources and emission:</p> <ul style="list-style-type: none"> Registration Evaluation through comparison to calculation <p>Characteristics and culture:</p> <ul style="list-style-type: none"> Indirect evaluation through quantitative measurements and description.
QUALITATIVE	<p>Energy design:</p> <ul style="list-style-type: none"> Occupant experiences/Cultural Probes Semi-structured Interviews Self-experience studies <p>Natural design solutions:</p> <ul style="list-style-type: none"> Occupant experiences/Cultural Probes Semi-structured Interviews Self-experience studies <p>Renewable energy:</p> <ul style="list-style-type: none"> Occupant experience/Cultural Probe Semi-structured Interviews Self-experience studies 	<p>Light:</p> <ul style="list-style-type: none"> Occupant experiences/Cultural Probes Semi-structured Interviews Self-experience studies TimeLapse studies Luminance photos/mapping Light narratives <p>Thermal environment, Indoor air quality and Acoustics:</p> <ul style="list-style-type: none"> Occupant experiences/Cultural Probes Semi-structured Interviews Self-experience studies 	<p>Resources and emission:</p> <ul style="list-style-type: none"> Occupant experiences/Cultural Probes Semi-structured Interviews Self-experience studies <p>Characteristics and culture:</p> <ul style="list-style-type: none"> Registered through photo registration Description Occupant experiences/Cultural Probes Semi-structured Interviews Self-experience studies

Table 2: What Methods Matrix (first draft): Matrix of *what* quantitative and qualitative *methods* to use for data collection related to each of the categories Energy, Indoor climate and Environment.
Source: (Authors production based on a compilation of the *Active House Specification* (Eriksen et al 2011))

5.2. ON WHAT TO MEASURE

The listed measurement parameters seem quite un-done – are they elaborated enough within the three categories to result in a holistic illustration and rightful fulfillment of the ambitious *Active House vision*?

Is it possible to state more elaborated qualitative parameters within *energy* and why does the descriptions of the parameters refer to the indoor climate category? Are there no qualities in energy?

The initial test-period of the experimental houses is presumed to indicate if, how and which proposed methods can answer to the stated measurement parameter. This will influence the further process revision of whether the measurement parameters are sufficiently accurate to answer the *Active House vision*.

The three measurement categories Energy, Indoor Climate and Environment and their listed parameters obviously have their restrictions at this stage of the *work-in-progress*. It would justify all of the categories to be further explored and elaborated in this attempt to establish a specification. This project will hopefully yield to defining the singular categories and parameters.

Measuring the sustainable homes will hopefully result in answers to some of the questions, providing for specifying the parameters within the three categories.

5.3. CHALLENGES TO THE EXPERIMENTAL SETUP

There are big challenges in this measuring setup. The experimental houses are designed and constructed by different companies, with different teams of architects, engineers, entrepreneurs and project managers, in different countries, different climate and different legal regulation and standards. The house designs, building traditions and materials are different, the habit of living and the people are different. These cultural aspects must stand in the background for the central aspects regarding environment – the ability to adaptation to climate and surroundings and the occupants' experiences of living in and with the sustainable houses. These aspects can help identify how we can make comparison across. This makes it possible to demonstrate differences and coincidences in occupants' wishes and requirements to a sustainable home in accordance with place.

5.4. ON HOW TO MEASURE

The proposed methods matrix suggests a lot of different methods through the Mixed Methods research strategy, but can the generous use of methods and scientific directions course for confusion rather than clarity in the explorations? Could the intent to research the different aspects of sustainable homes by triangulation course for blurred results or contrary results? It might. In that case, it is central to keep focus on the holistic purpose of the explorations. We are not searching for single rights or wrongs but rather for inspiring and interesting tendencies to support our hypothesis in qualified ways. Here, the professionalism and discernment of the researcher must be considered the right tool for determining the answers.

The study proposes methods to intercept qualitative aspects and set off to explore whether these methods are any good for the job?

5.5. ON RESULTS

In order to extract knowledge to implement in the further process the measurements must be analyzed properly and according to the idea of focusing on a holistic approach and the interplay between quantitative and qualitative aspects. What are more important – quantitative or qualitative aspects of the houses? If it is possible to make such a distinction is very relevant to the discussion of the need for a holistic approach.

5.6. ON ANALYSES

How do we treat and analyze data and information in order to be able to answer to the questions? The various methods and approaches calls for various analysis approaches. The data will be gathered in NVivo (qualitative data analysis software) (Lewins and Silver 2007)) and analyzed through an inductive approach to explore options in the data. Deductive and inductive analysis approaches will both be relevant to detect the worth of the data (Hastrup 2003).

The case study research (Yin 2009) approach to the setup for exploration enable for comparable studies in the analysis phases of the project. By using the same methods for data collection comparability studies will have similar premises and studies can be possible across e.g. different themes or typologies. The setup enables numerous permutations providing for uncovering both expected and unexpected areas of the explorations. Further strategies for data analysis will be uncovered in the succeeding stages of the project.

5.7. VALIDITY, RELIABILITY AND GENERALIZABILITY

This research project focus on sustainable homes spread across five European countries. The results of the three initial case studies in respectively Denmark, Austria and Germany will indicate whether this geographic extend hold any kind of generalizability.

It is our belief, that a vision of successful development of sustainable homes, as of sustainable architecture in general requires a more holistic approach regarding all phases of building, from

design phase to operation phase. Focus on holistic, inter-disciplinary design processes would make the preconditions for successful holistic assessment greater.

This initial proposal for systematically exploring sustainable homes cannot be considered a final answer to the issues, but rather an attempt to prove the validity of the hypotheses. Hopefully, this way of systemized method for gathering data will prove its worth. Very different methods and approaches are introduced for exploring different areas of the problem and discovering whether these support or undermine each other will be a key to deciding further development for the matrix.

6. CONCLUSION

The paper studies the *Active House vision* and the *Active House Specification work-in-progress* to identify what parameters to measure related to both quantitative and qualitative aspects in relation to the categories Energy, Indoor climate and Environment. On basis of the measurement parameters a set of methods are compiled into a matrix that defines what to measure regarding quantitative and qualitative aspects.

The conclusion is must evaluate the buildings on their preconditions – their design parameters and visions for the individual building to identify whether the design parameters are good enough. In order to answer to our questions we must analyze a combination of quantitative and qualitative data.

7. ACKNOWLEDGEMENTS

This paper is the second paper in the PhD project *A Method for Holistic Evaluation of Sustainable Buildings of the Future* where quantitative and qualitative measurements of seven buildings in five European countries - built according to the Active House vision - will contour the setup for development of a method for holistic evaluation of sustainable homes.

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Urbanized Ecosystems: Conceptualization to Application

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ABSTRACT

Urban areas are among the largest anthropogenic uses in terms of appropriation of land, energy, materials, and biological primary production, as well as in the alteration of the biogeochemical cycles of carbon, water, and nitrogen. Despite their significance in these respects, coherent descriptions and analyses of urban areas regarding the flux and cyclic processes of energy, materials, information and costs are relatively scarce. There exists an opportunity to investigate urban areas as analogous to ecosystems, thus allowing a complex, dynamical systems approach to be applied to the planning and management of built environments. Similar to how an ecologist studies natural environments within the hierarchical scale of an ecosystem, this novel approach is based on the investigation of urban areas as ecosystems onto themselves, or as urbanized ecosystems. Such an approach is scalable and transferable to neighborhoods, communities and regional applications.

The intent of this paper is to conceptualize urbanized ecosystems within a socio-ecological framework, so as to provide a basis for informed decision- and policymaking. Towards this end, this paper presents a methodology, Urbanized Ecosystems™ (UrbEcoSys™), developed as a proof of concept application for the Village of Oak Park, Illinois in 2009. This community was first conceptualized as a complex, dynamical ecosystem, based on scoping, inventorying, and assessing its critical variables and relationships as represented by the flux and cyclic processes of energy, materials, costs, and information. This conceptualization allowed a more formalized level of inquiry in the form of a system model. Findings in the form of baseline metrics were then used to develop alternative policy scenarios, which were then assessed relative to their alignment with the village's overall vision and policy. The outcomes from this assessment could then be used to support an informed decision- and policymaking process, prioritized within the municipal budget's allocation of finite resources.

CONFERENCE THEME: On Measurement: Quantifying sustainability, are we using the correct measures?

KEYWORDS: ecosystem model, system dynamics, sustainability metrics, urban ecology, resource allocation

I. INTRODUCTION

This paper is based on the research question; *How can the planning and management of urban areas be conceptualized as urbanized ecosystems, so as to provide a basis for informed decision- and policymaking?*

This research question was derived from a socio-ecological theoretical framework developed by the National Science Foundation (NSF) for the Long-Term Ecological Research (LTER) program (LTER 2007). This framework provided a hierarchical structure of research questions nested within each other, from which the research question was explicated from a broadscope to narrowscope refinement process. Following this hierarchical progression, the intent of this paper is to conceptualize urbanized ecosystems within this socio-ecological theoretical framework, so as to provide a basis for informed planning and policymaking. From this conceptualization, the investigation focuses on how does one model an urbanized ecosystem in terms of its associated energy, material, information and economic cost fluxes and relative to various temporal and spatial scales, so as to provide a basis for informed decision- and policymaking?

The response to this question is formatted as follows in this paper. First, the *purpose* for the line of inquiry to investigate urban areas as analogous to ecosystems is provided, so as to establish the rationale for urbanized ecosystems. Second, an overview of *prior studies* pertaining to urbanized ecosystems is provided, from the disciplinary perspectives of urban planning, ecology and urban ecology. Third, the research *methods* are explained, including approach and expected findings. Finally, the paper concludes with a proof of concept application, with a summary of findings and outcomes.

2. PURPOSE

Urban systems are among the largest anthropogenic uses in terms of appropriation of land, energy, materials, and biological primary production, as well as in the alteration of the biogeochemical cycles of carbon, water, and nitrogen. For these reasons, it has been said that urban areas are the defining ecological phenomenon of the twenty-first century (Newman & Jennings 2008). Despite their significance in these respects, coherent descriptions and analyses of urban systems regarding an accounting of the fundamental flows of energy and materials and the efficiency of critical processes are relatively scarce.

There exists an opportunity to investigate urban areas as analogous to ecosystems, thus allowing a multi-scale, dynamical systems approach to be applied to the flux and cyclic processes of urban areas. Similar to how an ecologist studies natural environments, a systems approach would be based on the flow and relationships of energy, matter, information and costs. The hierarchal scale of micro-, meso, and macro ecosystems is equivalent to the multiple scales of urban areas, suggesting a scalable ecosystems approach as an appropriate method for assessing urban areas as integrated human-natural environments. This novel approach would be based on what is termed by this paper as an *urbanized ecosystem*.

An urbanized ecosystem model would serve as a basis for how energy, materials, information, and economic costs interact on a complex and dynamic urban scale. For example, how energy and material inputs are processed, the resultant output of anthropogenic greenhouse gas emissions, and the life-cycle costs of policy scenarios, can all be informed by a system model that links the multiple scales and relationships between informational, energy, material, and social networks that constitute the essential functioning of integrated human-natural environments.

The need for better understanding of urban ecosystems emerges from two trends (Pickett et al. 2008). One is the process of urbanization², a dominant demographic trend and an important component of land transformation. The expansion of urban areas is a significant cause of natural ecosystem conversion to varying rural-urban gradients of integrated human-natural environments. As human populations continue to increase in abundance and distribution, higher ratio of people have been attracted to urban areas leading to increased urban development. In 2000, 79 percent of the population of the United States resided within urbanized areas³ or urban clusters⁴ (U.S. Census Bureau 2000). On a global scale, population has experienced unprecedented urban growth in recent decades. In 2008, more than 50 percent of the world's population lived in urban areas, or about 3.1 billion, with 95 percent of the world's population concentrated on just 10 percent of the world's land (World Bank 2009).

The second trend is that urbanized lands have a disproportionate impact on local, regional and global systems. Anthropogenic impacts of urbanization have been attributed to; altered land cover and hydrology (Arnold and Gibbons 1996), an area of impervious land cover of 110,000 square kilometers in the United States (Elvidge et al. 2004), altered energy dynamics (Karl et al. 1988; Spronken-Smith and Oke 1998), and concentrated areas of greenhouse gas emissions (Satterthwaite 2009). All of these facts point to the need for conceptualization and better understanding of urban ecosystems, to explain and predict the system dynamics and impacts. While planning theory addresses some of the individual ecological impacts when they directly affect human populations and their built environments, further research is needed to develop a system dynamics approach as applied to the planning and management of urbanized areas.

Recent research by the Millennium Ecosystem Assessment⁵ (MA) (2005) has identified significant gaps in socio-ecological research, the need for new theory, and the need for a better integration of conceptual and empirical research across a diverse set of approaches. MA advocates that new research must focus on understanding the long-term dynamic processes that are unique to socio-ecological systems versus purely social or purely biophysical systems. A new collaborative research framework is needed that integrates the internal and interactive dynamics of social and natural systems. According to MA, society is in need of fundamental research that transcends the ecological and social sciences, and demonstrates a commitment to the incorporation of social science into basic questions about ecosystem behavior, so as to transition to transdisciplinary⁶ collaborations.

Studying the interactions of cumulative environmental effects related to rapid urbanization requires important changes in research methods. The fragmentation and specialization of much planning theory and research needs to be coupled by transdisciplinary research that studies the connection and coherence among seemingly disparate flux and cyclic processes of energy, materials, information and costs. It is the intent of this paper to participate in this effort by investigating urban areas as analogous to ecosystems, thus allowing a complex, multi-scale, systems approach to be applied to the planning and management of integrated human-natural environments. Such a systems approach is intended to provide a basis for informed decision- and policymaking, in response to V.O. Key's (1940, 1138) classic resource allocation question 70 years ago; "On what basis shall it be decided to allocate x dollars to activity A instead of activity B?"

3. PRIOR STUDIES IN URBAN PLANNING, ECOLOGY AND URBAN ECOLOGY

While the interactions of humans with the urban environment have traditionally been the province of urban planners, there have been only intermittent cases when it has been based on ecological functions, processes, or ecosystem services. In following the theoretical thread for a synthesis between urban planning and ecology, the trail leads upstream through Peter Calthorpe, Ian McHarg, Lewis Mumford, Raymond Unwin, Ebenezer Howard and eventually to the riverhead known as Patrick Geddes (1854 – 1932). As a botanist, sociologist, geographer and town planner, Patrick Geddes' planning concepts were derived from geographical and biological principles that were part of his knowledge base, which allowed Geddes a synthesis of aesthetic, social and biological understanding.

Other attempts to synthesize planning and ecology are intermittent through time. In his *Teoría General de la Urbanización (General Theory of Urbanization)* of 1867, Ildefonso Cerdà (1815 – 1876) viewed the city the same way that a functional biologist views biological processes; that is, in terms how something is constructed and operates (Soria y Puig and Cerdà 1999). In Cerdà's writings, he uses biological principles, such as homeostasis, in his analysis of urban functions (Choay 1997). Frederick Law Olmsted intuitively linked environmental properties to human well being in cities. In particular, in Anne Spirn's *The Language of Landscape* (as cited in Pickett et al 2001), Olmsted's design for the Boston Fens and Riverway shows ecological prescience in its sophisticated combination of wastewater management and recreational amenity. In *Design with Nature* (1969), Ian McHarg devised an Ecological Planning Model which was further advanced by Frederick Steiner in 2000 for landscapes (Ahern 2004), which provides somewhat of a framework for an ecological-based approach to urban ecosystems.

Of special note is Jay Forrester's work in the 1950s and 60s with system dynamics, which dealt with the simulation of interactions between flows, rates and feedback loops, which provided the essential conceptual foundation for urbanized ecosystems. Forrester's work, specifically with *Urban Dynamics* (1969), provided the structure to study urban areas as a high order, nonlinear and complex system with multiple feedback loops, rather than a first-order, linear system with only negative feedback loops.

Urban ecology⁷ has focused on designing the environmental amenities of cities for people, and on mitigating the environmental impacts of urban regions. This planning perspective is normative and claims ecological justification for specific planning approaches and goals (Sukopp 1998). As presented by Mary Cadenasso, Department of Plant Sciences / University of California at Davis at a 2006 *Urban Ecology* symposium at Chicago Botanic Garden⁸, the study of urban ecology has historically developed in three phases. The first phase was represented by the Chicago School in the early 20th century (Park, Burgess, and McKenzie 1925) and focused on applying concepts of competition and niche partitioning from the ecological sciences to the sorting of groups in rapidly growing industrial cities. This approach was limited for its reliance in questionable ecological concepts and excluding individual behavioral decisions.

The second phase was based on the concepts of ecosystem metabolism and energetics that emerged in the 1950's by Eugene P. and H.T. Odum. This approach relied on the 'black box' approach, where inputs and outputs of the ecosystem are measured from which the functioning of the system could be measured. This approach was limited in that it failed to recognize the heterogeneity of systems,

and considered humans only as biological organisms. The inclusion of human ecology within a defined ecosystem is necessary so as not to be restricted only to biological ecosystem models. Human ecosystems are driven largely by the interaction of biotic and abiotic components through the flow of information, and therefore integral to an ecosystem model (Stepp et al. 2003). In a similar vein,

The third and current phase of urban ecology is based on contemporary ecological concepts that include spatial heterogeneity, resilience, and the complexity of integrated human-natural environments. The National Science Foundation (NSF) has long since recognized the important role of ecological science in furthering the understanding of urbanized ecosystems, as evidenced by the Long-Term Ecological Research (LTER) program. In fact, NSF claims the need for research that integrates the ecological and social sciences has never been greater (LTER 2007). This third phase is exemplified by the three overarching core areas of study of the Baltimore Ecosystem Study (BES)⁹, which is one the LTER programs funded by NSF. These core areas of study are as follows; 1) the structure of the system from biophysical, social, and built perspectives, 2) the fluxes of energy, matter, population, and capital, and 3) the feedback between eco-logical information and environmental quality.

4. METHODS

The assessment methodology for the study of urbanized ecosystems is both descriptive and explanative. Descriptive in the sense that it answers the research question in terms of *what, where, when, and how?* Towards this end, a major portion of the methodology is based on observations, data acquisition and collection concerning the development of a baseline inventory of a bounded urban area relative to the flux and cyclic processes of energy, materials, information, and costs.

Since it is not enough to describe the scope of urbanized ecosystems, it is also necessary to identify the *mechanism* that explains it. For this reason, causality is of primary importance. Therefore, since the research also examines the mechanism of *why*, the purpose of the research is also explanative. For example, quantifying the amount of stormwater runoff from various land cover is descriptive. Identifying the variable that explains why certain land covers have different amounts of stormwater runoff relative to other land covers is explanative. In order to determine how alternative planning interventions and policies influence an urbanized ecosystem structure and functions, a conceptual system model will be necessary in order to explain the likely outcomes and consequences in terms of energy, materials, information, and costs. Due the spatiotemporal uniqueness of each urban area, data acquisition and observations need to be place-specific to the urbanized ecosystem being assessed.

5. PROOF OF CONCEPT: VILLAGE OF OAK PARK

The above-described assessment methodology was further developed by the author as Urbanized Ecosystems™ (*UrbEcoSys*™), a proof of concept¹⁰ application for the Village of Oak Park, IL, modelled as a dynamical complex ecosystem. This 2009 study conceptualized the Village of Oak Park as an urbanized ecosystem, so as to allow a more formalized level of inquiry. From this conceptualization, the scope, inventory, and assessment of Oak Park's energy, materials, information and economics costs was completed, relative to their alignment with the village's overall vision and policy. The intent was to support and enhance an informed decision- and policymaking process, which then could be prioritized within the municipal budget's allocation of finite resources. The Village of Oak Park is a mature, built-out, inner ring suburb adjacent to Chicago in west central Cook County, IL (Fig. 1), with a population of 53,103 (U.S. Census Bureau 2005-2009).

For the study, the village was modelled as an urbanized ecosystem (as diagrammed in Fig. 2). The input environment (IE) consists of energy, materials, information, and economic cost flows which are then processed by the system into resultant outputs. Energy inputs consist of any primary energy source directly associated with the functionality of the village, such as electricity, natural gas, vehicular motor fuel, and renewable energy (solar, wind, ground source); as well as indirectly associated, such as food production / distribution, and water supply / distribution. Material inputs consist of all goods produced by, and imported into, the system, as well as food, water (via water supply system or precipitation) and other abiotic and biotic components of relevant biogeochemical cycles.

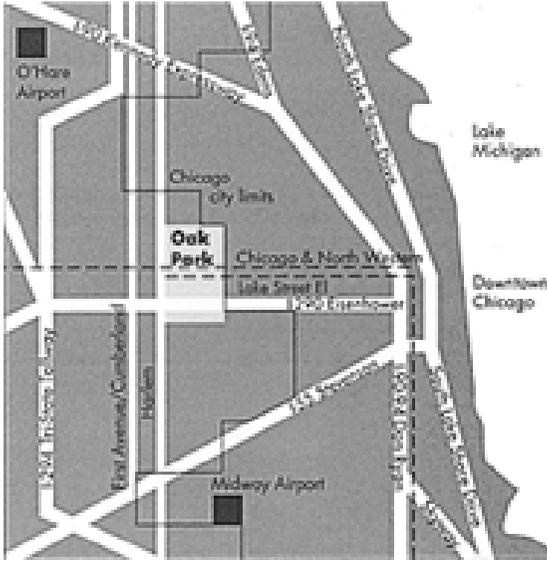


Figure 1: Location map, Village of Oak Park, IL. Source: (Author 2011)

The output environment (OE) is comprised of processed energy, materials, information, and economic cost flows that are stored, consumed, converted, and/or degraded as outputs. For example, energy is represented as a one-way flow through the system that is converted to outputs consisting of heat, organic matter and organisms. Materials are represented as biogeochemical cycles of chemical compounds which are processed with some impact on subsequent utility (Odum 1997).

Information for both IE and OE is in the form of biological (genetic) or anthropogenic (formal and informal) knowledge bases and communication networks. Economic costs are defined as the monetary valuation of associated system inputs and outputs. Within each system there are processes (negative and positive feedback loops, energy circuits, heat sinks, etc.) which are governed by the laws of nature (photosynthesis, decomposition, etc.) and thermodynamics. While not a system variable itself, land use / land cover is a system determinant in the processing of energy and material inputs and subsequent outputs. Additional information is provided at 5.2. *Phase 2 – Inventory*.

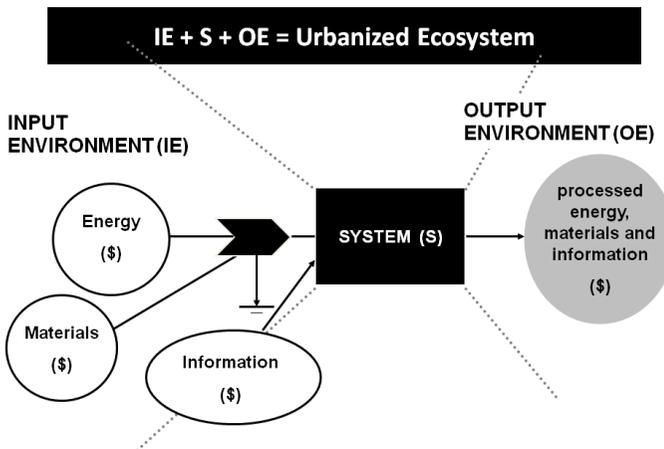


Figure 2: Diagram of ecosystem model. Source: (Author 2011)

Complex adaptive system models are based on equations reflecting known relationships between variables. Ideally, one would complete a comprehensive and detailed model of the Village of Oak Park which would include algorithms of all relevant energy, material and economic cost flows. If such a model existed, one might be able to predict with reasonable certainty where the village is headed in the future, foresee problems, and be guided to take action to avoid or mitigate adverse impacts. Unfortunately, no such model exists, and one will likely not be developed in the near-term future due to the overwhelming level of complexity inherent with the social systems of communities. For this reason, a narrative conceptual system model was used for the study of the Village of Oak Park.

Despite the inherent uncertainty of complex urban systems, it remains essential to inventory the essential components of an urbanized ecosystem, so as to establish baseline metrics and indicators that could provide accurate and reliable information about the viability, efficiency and costs of the system. This completion of an inventory is independent of any particular ideological view currently adopted by a community. Findings of the *UrbEcoSys*[™] study were provided to the Village of Oak only as an assessment, rather than as planning and policy recommendations. How much value the village assigns to particular findings is a matter for public dialogue and policymaking, and should be derived from the village's overall vision and policy.

While the study left the assigning of values to the Village of Oak Park, it does rely upon a working concept of sustainability¹¹ to reference its assessment and findings. For the purpose of *UrbEcoSys*[™], sustainability, at its core, is defined as an effort to create and maintain a dynamic regime of the Earth under which human population and its necessary material and energy consumption can be supported indefinitely by the biological system of the Earth. Sustainability, in fact, is not like a goal that can be reached, but rather like a corridor through time that must be followed (Cabezas et al. 2003).

In order to establish a reasonably detailed model of the Village of Oak Park, the following three separate phases were completed as part of *UrbEcoSys*[™]; scoping, inventory, and assessment.

5.1. PHASE I - SCOPING

Scoping defines the extent of analysis and the system boundaries. The boundaries for this project were defined as the geopolitical municipal boundaries of the Village of Oak Park; 1.5 mi. (2.4 km) by 3.0 mi. (4.8 km), or 4.5 mi² (11.7 km²). As certain externalities (such as the political economy) and flows (such as air pollution) do not adhere to human-fabricated boundaries, the scale of the system boundaries is not only local, but regional, national, and even global as well.

That being said, it was not within the scope of the study to include cultural, social, and political concerns beyond the defined geopolitical boundaries of the Village Oak Park, although they were referenced as necessary. It should be also noted that *Phase I – Scoping* did not include the inventorying of energy, material, information, and cost flows related to overlapping government agencies other than the Village of Oak Park (such as school districts, park district, and township), although it may have included the spatial analysis of their land use / land cover in relationship to village- and privately-owned property.

5.2. PHASE 2 - INVENTORY

An inventory is required to provide all essential information about the viability of an urbanized ecosystem, and to serve as a benchmark for evaluating its future rate of change. It can also measure the system's performance relative to the village's overall vision and goals, as well as a basis for comparison with other communities. An important part of an inventory is identifying the essential networks and relationships within a system. This requires a process of aggregation and condensation of available information and data, and the directed search for missing information needed for a comprehensive description of the system.

The *Inventory Phase* consisted of the data compilation and documentation towards inventorying the current energy, material, information and cost flows to (inputs), through (throughputs), and from (outputs) the system boundaries of the village. This included a quantification of demographics (population, households, vehicles, etc.), infrastructure, energy inputs (solar radiation, wind profile,



Figure 3: Village of Oak Park. Source: (U.S. Census Bureau 2005-2009)

electricity, natural gas, motor fuel, etc.), energy outputs (pollution and greenhouse gas emissions), solid waste outputs (refuse, recyclables, yard waste, leaf litter), water inputs (precipitation, water supply, system leakage, etc.), and water outputs (stormwater, sewage, surface runoff, combined sewer overflow events, etc.). Energy and material flows are provided in terms of quantity (amount, costs, associated taxes, waste), type (residential, commercial, industrial, and municipal) and scale (individual, household, property, village-wide).

The *Inventory Phase* data sources were comprised of images, maps, digital orthophotos, and field measurements, primarily provided by the Oak Park Department of Public Works. Interviews with key division superintendents were completed to derive and compile specific data pertaining to public infrastructure, village fleet, capital improvements, operating and maintenance expenses, etc. Data was also made available from the local electric and natural gas utility companies concerning village-wide energy inputs and costs. The inventory also included GIS applications for representation and process modelling, based on the availability of GIS-related files from the Village of Oak Park. ESRI's ArcView 9.2 was used, along with such extensions as ArcGIS Spatial Analyst and Network Analyst.

5.3. PHASE 3 - ASSESSMENT

For most municipalities, the decision- and policymaking process relative to environmental-sustainability is somewhat fragmented and ad hoc. It is imperative that any assessment methodology be contextually relevant and place-specific, so as to capture the unique spatiotemporal attributes of an urbanized ecosystem. While a generic checklist of best practices are often referenced by planners as a guide for assessment methods, they often do not reflect the unique attributes unique to any specific place and time.

For an assessment methodology to be more than a checklist of best practices, a systems-based integrative approach is needed to seek interrelationships, patterns and synergies. The purpose of the *Assessment Phase* is to characterize and assess the viability and efficiency of the urbanized ecosystem *in situ*, as well as subsequent rate of change by using the baseline data and information obtained from the *Inventory Phase*. Towards this end, The *Assessment Phase* identifies 'synergies' and 'conflicts' between interrelated planning interventions. 'Synergies' are the interaction of two or more agents or forces so that their combined effect is greater than the sum of their individual effects 'Conflicts' include any interventions that adversely effect the performance or outcome of another strategy.

The *Assessment Phase* provides the ‘logic’ to assign prioritization relative to the potential effectiveness of planning interventions and policy, according to; 1) the level of difficulty in implementing the intervention in terms of expertise and technology (readily achievable, not readily achievable, not achievable); 2) the applicable time scale of implementation (immediate, near-term and long-term); and 3) the relative initial and life-cycle cost of implementing the intervention relative to a municipality’s budget, external funding, and return on investment.

6. FINDINGS

The findings were provided as deliverable outcomes to the Village of Oak Park as a 108-page report (Oak Park 2009) on October 6, 2009, that included the baseline inventory, summary of assessment, and a review of critical next steps. While it was found that the Village of Oak Park had several exceptional attributes relative to peer communities, it still had the challenge of having an ecological footprint that far exceeded the carrying capacity at various local, regional, and global scales. While most of this excessive ecological footprint (Wackernagel and Rees 1996) is inherent for any community that is located within the infrastructure and standard of living of the United States, there were two primary issues that became apparent during the course of this study that are specific to Oak Park, as follows;

- The existing disconnect of accountability between those who derive the benefits of potential planning policy, and those who bear the costs. During the investigation, there appeared to be not only a lack of incentives to initiate potential planning interventions and policy, but often disincentives as well.
- The lost opportunity of not taking advantage of available renewable resources, while instead relying on an energy intensive, inefficient, and costly infrastructural system.

The following are but a few examples of these two issues.

6.1. ACCOUNTABILITY – WATER USAGE

Oak Park receives an annual rainfall of 35.8” (91.0 cm) / year (Illinois State Climatologist Office 2009), or 2.8 billion gallons. About 60 percent of this rainfall falls upon impervious land cover (streets, alleys, roads, parking lots, roof-tops, etc.); whereupon it is channeled to Oak Park’s combined stormwater / sewer system. This system is connected 6 miles (9.7 km) downstream to the Stickney Waster Reclamation Plant of the Metropolitan Water Reclamation District (MWRD) of Greater Chicago.

The Village of Oak Park pays a wastewater treatment fee to MWRD which is based upon the amount of supply water provided to Oak Park from Lake Michigan via the City of Chicago. Property owners in Oak Park also pay an additional wastewater treatment fee to MWRD through their Cook County property tax bills, based on their property’s estimated assessed value. Therefore, there is no economic incentive for the Village of Oak Park collectively, or property owners individually, to reduce their stormwater / sewer discharge, as there will be little, if any, cost savings benefit.

Based on the runoff coefficients (Ritter, Kochel, and Miller 2006) of the impervious land cover, approximately 1.7 billion gallons per year of stormwater output is discharged to MWRD. In 2008, the Village of Oak Park imported over 2 billion gallons per year of Lake Michigan supply water from the City of Chicago, at a cost to Oak Park resident end users of \$8.8 million (Oak Park 2008c). As such, rainfall is being diverted to MWRD, the Village of Oak Park is paying the City of Chicago to pump, process, and deliver water from Lake Michigan for watering yards and gardens, washing cars, and other nonpotable water uses. Therefore, based on this accounting, while stormwater mitigation and/or treatment have no economic benefit to local residents, supply water use reduction has a double economic incentive.

6.2. RENEWABLE RESOURCES - ENERGY

Oak Park receives a vast amount of solar radiation within its 4.5 mi.² (11.7 km²) of land area. In terms of energy, Oak Park receives between 67M Btu/day during December, and 256M Btu/day during June (United States 1976). While this supply of solar energy is largely unused, in 2008 Oak Park residents imported 161M kWh of electricity from the local electric utility, Commonwealth Edison, at a cost of \$21.9 million (Oak Park 2008a). In 2008, residents also imported over 26.4M therms per year from Nicor at a cost of \$30.3 million (Nicor Gas 2008).

The resultant annual greenhouse gas emission in 2008 from this consumption of electricity included over 36.2M lbs. of carbon dioxide (CO₂). Resultant air pollution emissions also included 375,000 lbs. of sulfur dioxide (SO₂), and 599 lbs of high level nuclear waste (Commonwealth Edison 2009).

Despite this disconnect between available solar radiation with expensive, fossil-fuel or nuclear-based energy sources, it was found that the Village of Oak Park had a disincentive for reducing their imported energy use. The municipal utility tax on Commonwealth Edison residential energy billings was nearly \$1M per year, while the municipal utility tax on Nicor billings was \$1.6M per year (Oak Park 2008b). Therefore, any reduction in electrical or natural gas usage would significantly reduce a primary revenue stream in the village operating budget's General Fund. A proposed policy to address this disconnect needed to be assessed from a multi-criteria, cost-benefit viewpoint. As such, three policy scenarios were completed (Table 1) for 10%, 20%, and 30% energy use reductions relative to the 2008 baseline. Associated impacts were calculated for energy cost reduction for residents, municipal utility tax reduction, greenhouse gas (CO₂) reduction, and high-level nuclear waste reduction.

6.3. ACCOUNTABILITY – WALKABILITY

Although Oak Park was originally planned and developed as a highly decentralized and walkable community, recent growth and development trends in the Chicago metropolitan area have exerted pressure on inner-ring suburbs, such as Oak Park, towards becoming a more centralized, auto-centric community. For example, in 1917, there were 2,372 autos registered in the Village of Oak Park (U.S. Works Progress Administration 1937). With a population at that time of 34,876 persons, that was

Annual Residential Electric Energy Use Reduction Policy Scenarios	2008 Baseline	Scenario A 10% Reduction	Scenario B 20% Reduction	Scenario C 30% Reduction
Usage (kWh) [usage reduction]	160,951,051 ---	144,855,946 [1,609,511]	128,760,841 [3,219,021]	122,665,736 [4,828,532]
Costs (\$) [cost reduction]	\$21,853,416 ---	\$19,668,074 [\$2,185,342]	\$17,782,732 [\$4,370,683]	\$15,297,391 [\$6,556,025]
Municipal Utility Tax (\$) [tax revenue reduction]	\$965,706 ---	\$869,135 [\$96,571]	\$772,565 [\$193,141]	\$675,994 [\$289,712]
CO ₂ (lbs.) [CO ₂ reduction]	36,217,335 ---	32,595,601 [3,621,734]	28,973,868 [7,243,467]	25,352,134 [10,865,200]
High-level nuclear waste (lbs.) [waste reduction]	599 ---	539 [60]	479 [120]	419 [180]

Table 1: Policy scenarios for electric energy use reduction in Oak Park, IL relative to 2008 baseline. Source: (Author 2011)



Figure 4: Urbanized Ecosystem v1.0 Source: (Author 2011)

one vehicle for every 15 residents. There are currently over 30,095 vehicles registered in Oak Park, with a population of 53,103 (U.S. Census Bureau 2005-2009), which is one vehicle for every 1.8 persons.

The net result is more Oak Park residents are being influenced to use their vehicles for local destinations, such as stores, parks, and schools, rather than walking or biking. To accommodate the increased vehicular traffic, the Village invests significant capital funding to construct, operate, maintain, and secure an infrastructure that is necessary for a more auto-centric community. Additional adverse impacts are also incurred from increased pollution emissions and resultant public health risks (such as asthma), decreased walking/exercise and resultant public health effects (such as obesity), and increased fossil fuel usage associated with global warming and security risks.

7. NEXT STEPS

The application of *Urbanized Ecosystems™ (UrbEcoSys™)* to the Village of Oak Park was a proof of concept. The next version is intended to build upon the lessons learned from *UrbEcoSys™v1.0*. The next step would be an Improvements Analysis, based on discussion and feedback from the village officials upon review of the finding resulting from the *Scoping, Inventory and Assessment Phases*. The amount of data and information gathered and compiled for this study has been comprehensive, and every effort has been made to compile, organize and integrate this information in a meaningful manner for various users. But the existing village data tended to be fragmented and decentralized, and a measurement, reporting and verification protocol is needed to ensure quality assurance of data.

While not included in the scope of this project, a recommended next step for the inventory phase would be to include relevant footprint analyses, such as a more comprehensive ecological footprint, greenhouse gas emissions footprint, and carbon footprint, completed both on individual household and village-wide scales.

Another next step would be to include the input of the inventoried data sets representing the energy, material, information, and economic cost flows within multiple and integrated Excel workbooks. This enhanced user-interface and functionality would allow causal relationships between data sets to be better realized for scenario building and projections, allowing village officials the capability of interactive decision- and policymaking that is necessary with regard to the complex adaptive system known as the Village of Oak Park.

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ENDNOTES

1. While the concept of *urbanized ecosystems* is derived from urban ecology, it remains distinct in its usage for this paper for an important reason. Urban ecology, as a subfield of ecology, focuses on the 'ecology *in* cities', while urbanized ecosystems focuses on the 'ecology *of* cities' (Grimm et al. 2000). The investigation of urban ecosystems requires a significant conceptual change in the way planning research frames questions about urban environments (Alberti 2009). Instead of asking, "How do humans affect ecological systems?" the question becomes, "How do humans interacting with their biophysical environment generate emergent collective behaviors (of humans, other species, and the systems themselves) in urbanizing landscapes?"
2. *Urbanization* is the increase in the proportion of a population that is urban as opposed to rural. It refers to the proportion of the total population concentrated in urban settlements, or else to a rise in this population. Since the total population is composed of the urban population and the rural, the proportion urban is a function of both (Davis, 1965).
3. *Urbanized area* is an area consisting of a central place(s) and adjacent territory with a general population density of at least 1,000 people per square mile of land area that together have a minimum residential population of at least 50,000 people.
4. *Urban cluster* is a densely settled territory that has at least 2,500 people but fewer than 50,000.
5. The *Millennium Ecosystem Assessment (MA)* was called for by the United Nations in 2000, and carried out between 2001 and 2005. The objective of the MA was to assess the consequences of ecosystem change for

human well-being and the scientific basis for action needed to enhance the conservation and sustainable use of those systems and their contribution to human well-being. The MA was undertaken by an international network of scientists and other experts, with a process modelled on the Intergovernmental Panel on Climate Change (IPCC).

6. *Transdisciplinary* research is characterized by a process of collaboration between scientists and nonscientists on a specific real-world problem. This requires an epistemology, methodology and organization that go beyond disciplinary research. Knowledge and values from outside the realm of science are integrated into the research process. At the same time, the research process is opened up to the stakeholders, aiming at a mutual learning process (Walter et al. 2007).
7. *Urban ecology* is ecological research done in urban areas, which for the purpose of this paper, is a geographical term characterizing the land use of an area (Niemelä 1999). *Urban ecosystems* are those in which people live at high densities, or where the built infrastructure covers a large proportion of the land surface (Pickett et al. 2001). Beyond definitions, there are two distinct meanings of urban ecology in the literature (Sukopp 1998). One is a scientific definition, and the other emerges from urban planning. In ecology, the term urban ecology refers to studies of the distribution and abundance of organisms in and around cities, and on the biogeochemical budgets of urban areas. Urbanized ecosystems, the epicenter of human environmental impact, have traditionally not received adequate attention from ecologists (Kloor 1999). This may be because ecology has its roots in a worldview that stressed balance and equilibrium and regarded disturbance in general, and human intervention in particular, as a deflection from the more representative workings of ecological systems (Botkin 1992). Since these conditions were associated with more pristine conditions, as perceived in wilderness locations, this is where much of twentieth century ecology focused its attention. Urban ecology is now emerging from a long period of neglect and becoming an important disciplinary focus (Goode 1989).
8. Cadenasso, Mary L., "The Evolution of Urban Ecology in the United States: Application of Contemporary Ecological Concepts in Urban Systems" (keynote address presented at the Urban Ecology: Celebrating Ten Years of Chicago Wilderness symposium, Chicago Botanic Garden, October 20, 2006). The Baltimore Ecosystem Study (BES) conducts research on metropolitan Baltimore as an ecological system. The program integrates biological, physical, and social sciences. As a part of the National Science Foundation's Long-Term Ecological Research Network (LTER), BES seeks to understand how Baltimore's ecosystems change over time.
9. The Baltimore Ecosystem Study (BES) conducts research on metropolitan Baltimore as an ecological system. The program integrates biological, physical, and social sciences. As a part of the National Science Foundation's Long-Term Ecological Research Network (LTER), BES seeks to understand how Baltimore's ecosystems change over time.
10. *Proof of concept* is a short and/or incomplete realization of a certain idea to demonstrate its feasibility, or a demonstration in principle, whose purpose is to verify that some concept or theory is probably capable of exploitation in a useful manner.
11. While *sustainability* was listed as one of the frameworks from which to choose, terms relative to the specific application, such as *urban ecology*, are preferred. The use of the term sustainability is often arbitrary and ill-defined, which may result in confusion and misinterpretation. The term sustainability is a transitive verb which requires both a subject and object(s). Therefore the use of this term requires the inclusion of 'what is being sustained', and 'who is doing the sustaining'. Since the root word *sustain* is commonly defined as to 'keep in existence, maintaining', the term sustainability connotes something that will persist indefinitely. Since there is no natural or human-designed system that persists indefinitely, the use of the term sustainability needs to be within this conceptual framework

Louvered door research and development for user needs and energy efficiency in Thailand's context

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ABSTRACT:

This research and development project aims to investigate and propose practical louvered door solutions in terms of energy saving, human dimension (physical, psychology, social and cultural human factors), as well as feasibility regarding production and engineering. One project achievement comes from an interdisciplinary collaboration among specialists in indoor air quality and energy management, user-centred design, as well as product design and engineering. To achieve energy efficiency where practicality could be reached, the research results have led to design criteria in three aspects including architecture and indoor environment (energy efficiency, thermal comfort and indoor air quality), human dimension (convenience in operation and maintenance, styling preferences, privacy and security), as well as production and engineering (feasibility in production and installation, durability and ease of repair). Four design directions were generated and produced. Prototypes for each design direction were tested for four main aspects including energy-efficiency performance in a laboratory via the blower door technique (area leakage, pressure and air flow volume), usability by scenario testing with follow-up interview, styling preferences through visual tool kit with follow-up interview, and production and engineering feasibility by expert testing and interview. In assessing all the aspects, and based on conclusions drawn from evaluation, the most promising design direction does not correspond with the highest energy-efficiency performance; rather, it is the direction that best compromises between energy efficiency and human dimension. Apparently, to achieve the design of energy-efficient architecture, solutions should not be concerned solely with technical and scientific aspects, but must accept a need to integrate additional human dimensions that influence energy efficiency for both practicality and acceptability purposes.

CONFERENCE THEME: On measurement

KEYWORDS: louvered door, human comfort, energy efficiency, human dimension, user needs

INTRODUCTION

Architectural Design and Construction in Thailand was, in ancient times, very different to current practices. The climate back then was not as extreme and it was still possible to bring temperature down to a human's comfort zone by improving the microclimate. The majority of houses/buildings were made of wood and assembly was non-airtight with many operable windows. There was a crawlspace of sufficient height that no one had to really crawl at all. It was in fact used, when there was no flood, as "office" space. A high-pitch gable roof was typically the style of choice, because it allowed for stack ventilation in the attic. The classic planning pattern consisted of many semi-outdoor spaces such as patios and balconies and people frequently spent time in these semi-outdoor areas. Given all this, it is sensible to say that the houses/buildings were designed to be truly climate-responsive. It was, by nature, that natural ventilation played an important role in providing both comfort and good indoor air quality (IAQ), with operable windows and doors acting as essential elements in an indoor environment. Subsequently, infiltration and ex-filtration had become preferable as supporting criteria, whereas wooden structures and wooden architectural elements which are not air-tight were significant factors.

Milder climate condition aside, in earlier times, another prominent factor was a safer neighbourhoods that allowed this change in ventilation to happen. Explosive population growth however ushered in land-use limitations, a decrease in society's security and privacy as well as increased atmospheric pollution. In answer to this, modern architectural design gradually eroded Thai architectural design. Houses have become more and more compact to accommodate the need for efficiency use of space. Entire buildings have gradually become more and more airtight to house the need for air-conditioning systems. However, in contradiction to this, IAQ has still remained an issue. This has led to a need for louvered doors, essentially to allow for a modest portion of natural ventilation, as a passive repair when occupants require the removing of odour and humidity. Given all these reasons, a development of louvered doors and sometimes, windows came in as a vital feature that naturally allows for needed ventilation for both comfort and IAQ, while retaining privacy and possibly security.

The world has indeed become warmer, and Thailand is no exception. Thailand is located near the equator, which is to say that the country already possesses a hot and humid climate. The destruction of rain forests and natural resources in the region, coupled with global warming, have elevated Thailand's climate out of the human comfort zone towards an incomparably hot climate. During the hot season, the temperature in Thailand can reach 38–40° Celsius. This climate shift has necessitated a change in architectural design. Furthermore, air-conditioning systems – mechanical ventilation – have become an unavoidable solution to the problem of Thai modern architecture, allowing temperature and high humidity levels to be brought down to meet human comfort needs. As a consequence, electricity consumption in Thailand has grown rapidly with electricity consumption levels tripling during the last two decades alone (EPP0 2009). In 2009, electricity usage in the residential sector was about 25 per cent of the country's total consumption (MEA 2010) with one fifth of residential electricity consumption utilised for air-conditioning (DEDE 2004). While there have been growing demands for efficient household energy consumption in Thailand, there has not been enough research and development concerning energy-efficient louvered doors.

Most louvered doors in Thailand have unadjustable slats which remain open to allow air to pass through constantly. Louvered doors, featuring angle-adjustable slats to accommodate energy-efficient needs in air-conditioned buildings, offer the option of being closed to reduce the cooling load of air-conditioning systems. However, existing adjustable louvered doors are not capable of completely preventing infiltration and ex-filtration due to inherent leakages. It has, furthermore, been found that these adjustable slats are usually left opened on all occasions. With this in mind, adjustable louvered doors clearly do not aid in energy efficiency with respect to air-conditioning systems as intended (Lehtonen et al. 2008). Many studies on household energy efficiency reveal similar phenomena, that of energy-saving household appliances often being left on day and night (Lilley et al. 2005, Lockton and Harrison 2009, Lockton et al. 2009). This evidently demonstrates a need for taking a human dimension – user needs and behaviours – into consideration across design fields (Brown et al. 2010, Hadjri and Crozier 2009, Lehtonen 2010, Preiser 1995). To date, many architectural design projects have used post-occupancy evaluation to get end-user feedback on the performance of the building following the building being occupied. However, information gathered in such a manner can only be used to either remedy minor things in a building or be used as a lesson learned for future projects. It would indeed prove more fruitful for the project if this working approach were to occur throughout the design process (Hadjri and Crozier 2009, Preiser 1995).

I. ENERGY-EFFICIENT LOUVERED DOOR RESEARCH DESIGN PROJECT

I.1 PROJECT OVERVIEW

This project was carried out between 2004–2008 with the Residential Energy Conservation Promotion Fund from the Energy Policy and Planning Office of the Ministry of Energy in Thailand. Although louvered doors are commonly used in Thailand, available designs on the market fail to accommodate energy conservation. The main funding objective was thus to develop *louvered doors that could decrease the energy loss of air-conditioning systems in residential buildings*. It is known however, that louvered doors are not the only solution to this problem. Transom louvers are also used to provide ventilation without compromising security. Higher technical solutions such as thermally activated sensors that automatically close louvers could also be open to consideration. However, according to the given scope of this funding, the central concern was placed firmly on energy-efficient louvered door design.

Besides the funding objective to develop louvered doors to accommodate energy conservation by preventing infiltration and ex-filtration in air-conditioned housing; the project also aimed to develop louvered doors that would enhance the human dimension, respond to residents' needs and behaviours, as well as remain feasible to produce, install, maintain and repair. To achieve all project objectives, an interdisciplinary team – consisting of IAQ and energy management, user-centred design, as well as product design and engineering specialists – worked closely together throughout the duration of the project. The project began with a research period that helped to specify design criteria. Later, based on the aforementioned design criteria, different design directions were generated. Each design was then evaluated using the appropriate methods to gain adequate feedback for design selection and development.

1.2 DESIGN CRITERIA

At the beginning of the project, a literature review and survey consisting of 165 Thai households were carried out in 2005 to gain an understanding of requirements that should be concerned when designing louvered doors to achieve energy efficiency where practicality could be reached. Both studies focused on human comfort and indoor air environments in residential architecture, more specifically, louvered doors and their usage in air-conditioned housing as well as residents' behaviours and needs related to louvered doors. Insights derived from studies were used to establish the louvered door design criteria in three aspects including architecture and the indoor environment, the human dimension, and production and engineering. All design criteria used in the project is discussed below:

1.2.1 Architecture and the indoor environment

The principles for passive and active building design are in partial conflict. This is because passive buildings are devoted to natural ventilation together with infiltration and ex-filtration; whereas active buildings need to be air-tight as leakage is not desirable. Nowadays, building materials and construction in Thailand largely depend on air-tight materials and assembly methods, such as reinforced concrete, brick and mortar, aluminium windows, etc. However, in order to achieve good IAQ, that is, remove odour and humidity in spaces where they are created such as toilets, bathrooms and kitchens (Buranasomphob, 1978), louvered doors have constantly appeared as the dominant solution. It is practical to suggest that air-conditioned spaces should not be adjacent to non air-conditioned spaces. It would also be practical to recommend that vestibules should be provided between air-conditioned and non-air-conditioned spaces. Nevertheless, it has been found that in typical Thai modern houses, louvered doors are commonly installed in toilets, bathrooms and kitchens, and are located immediately adjacent to air-conditioned spaces such as bedrooms and living rooms (Lehtonen et al. 2008). According to this finding, it is foreseeable that ventilation and leakage of humid air will continue to place a significant burden on air-conditioning systems. Air-conditioning systems in Thailand ordinarily function through several main features: de-humidify the air, cool it down, and circulate it. Infiltration of hot and humid air into air-conditioned spaces should be avoided for energy conservation purposes. Therefore, louvered doors should not only function perfectly as a gateway to attaining good IAQ, but should also, when in use, operate as air-tight elements that avoid infiltration into adjacent air-conditioned spaces. With this in mind, human comfort and good IAQ are equally important.

1.2.2 The Human dimension

Aspects of Human dimensions are concerned with how a louvered door meets residents' needs and behaviours, ensuring practicality and acceptability. To meet human dimension requirements, the slats of a louvered door should be both convenient to open when air-conditioning is required, and to close when it is not. It should be easy to clean and maintain, since slats easily collect dust and dirt. It should provide residents' privacy by preventing him/her from being seen from the other side of the door, especially when the door is installed in areas where privacy is highly required such as toilets, bathrooms, and areas facing outdoors. As a louver structure weakens, a door's strength is

compromised making it almost effortless to break into. As such, a stronger louvered door structure that enhances residents' security is also needed. In addition, as doors are also a part of the interior, many residents take their aesthetic appearance into consideration. Since aesthetics and styling remain additional decisive factors, their design should allow them to easily co-ordinate with different interior styles. In a real situation, *sale price* is another important criteria for the decision to purchase, which can determine the economic success of the product (Ulrich and Eppinger, 2000). However, due to project limitation, the *unit cost* influencing the sale price could not be estimated and therefore *sale price* was not included in the project's human dimensions.

1.2.3 Production and engineering

To ensure local production and local market feasibility, the louvered door should be easy to produce, install and maintain. Moreover, the door should be strong and durable as well as mould- and rust-resistant because it is often installed in moist and humid areas. When a door breaks, it should be repairable. Hence, the project focused on developing low-technological – manually operated – louvered doors.

1.3 DESIGN DIRECTIONS

Four design directions were generated from the design requirements previously mentioned. Please note that as the scope of the project was to propose *conceptual* louvered door solutions, the project's main focus was the principles of the doors while detailed designs such as louvered blade designs and material selection were not part of the design project and therefore not considered variables to affect design directions. Furthermore, a screen for insect control, an important feature for tropical architecture (Buranasomphob, 1978), was recommended to be installed in each door design. The design directions proposed for this project included:

1.3.1 Design A

Design A (Fig. 1) is an add-on to an existing louvered door with unadjustable slats. It is a solid panel that can be attached to the louvered door and hinged on one side. The design works as another opening door that can be opened to ventilate the room or closed to prevent the room's infiltration and ex-filtration.

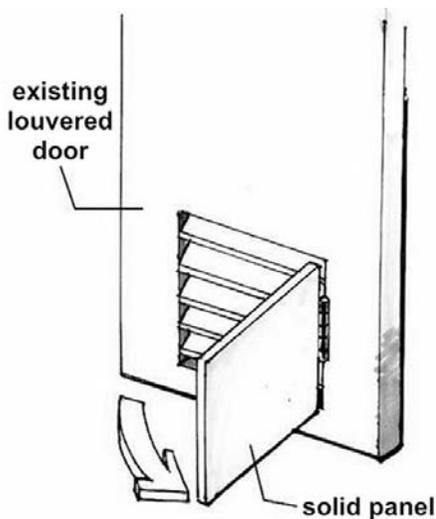


Figure 1: Louvered door design A

1.3.2 Design B

Design B (Fig. 2) is an add-on to an existing louvered door with unadjustable slats. It is a solid panel with a sliding system, which can be attached to the louvered door. The design works as another sliding door that can be opened to ventilate the room yet closed to prevent any infiltration and ex-filtration.

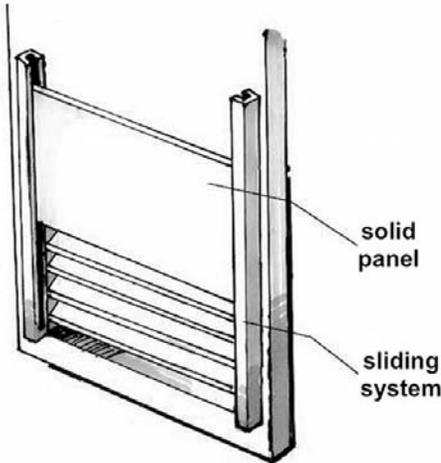


Figure 2: Louvered door design B

1.3.3 Design C

Design C (Fig. 3) is a louvered door with angle-adjustable slats. When needed, a slat controller in the middle of the door can be used to conveniently open and close all slats. There is a rubber sealer on the edge of each slat to increase air-tightness when the louver is closed.

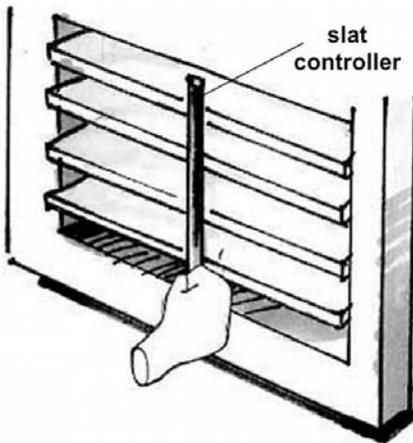


Figure 3: Louvered door design C

1.3.4 Design D

Design D (Fig. 4) is a door with a set of vents. Inside the door, there is a solid panel which can be lifted up to allow air to pass through the vents and can be pulled down to prevent air leakage.

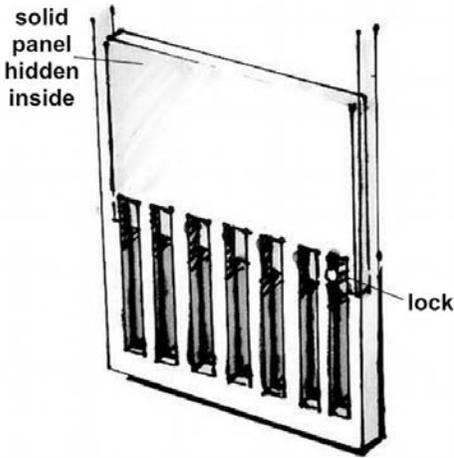


Figure 4: Louvered door design D

2. METHODS

All prototypes for each design direction were assessed in terms of energy-efficiency performance, usability, styling preference, as well as production and engineering feasibility. Four testing sessions for design direction assessment included:

2.1 ENERGY-EFFICIENCY PERFORMANCE TESTING

Prototypes for all design directions were tested for energy-efficiency performance in a laboratory via the *blower door technique* (Fig. 5). The blower door technique takes into account relationships between area leakage, pressure, and air-flow volume. Our modified *blower door* contained a variable speed fan so that the pressure in the test chamber could be adjusted. In order to measure the leakiness of each designed door, the blower door measured both the air flow through the fan and the pressure difference between the inside and outside of the chamber. (INFILTEC 2008)

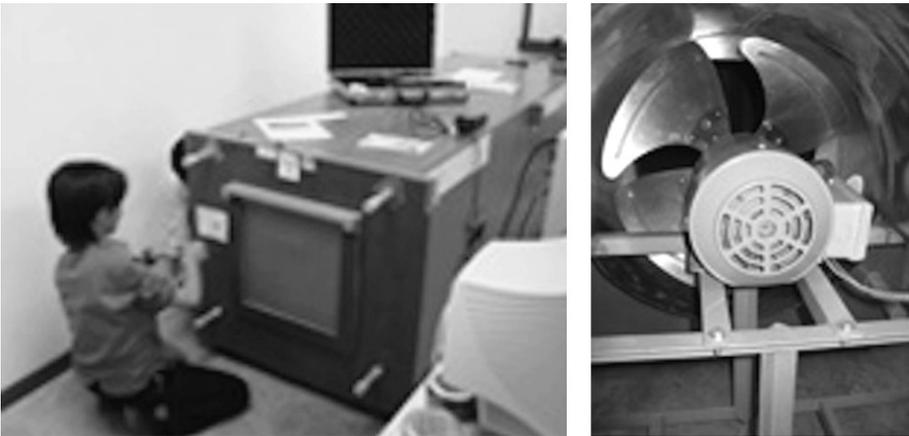


Figure 5: Blower door technique

2.2 USABILITY TESTING

Prototypes for all design directions were set-up in a simulated environment. By using the *usage scenario method* (Fig. 6), 18 participants with various profiles – ages, genders, living types and backgrounds – were asked to perform tasks with each prototype according to given situations relating to four aspects including, ease of louver open-close operation, ease of cleaning and maintenance, privacy, and security. In *follow-up interviews*, participants were then asked to rank each design direction, then to give their opinion based on their degree of satisfaction in all four factors mentioned earlier.



Figure 6: Scenario testing

2.3 STYLING PREFERENCE TESTING

Styling testing divided interior styles into 6 categories; general, warm, classic, elegant, modern and natural. To verify user styling preference, a *visual tool kit* (Fig.7) consisting of 48 cards was presented to all participants aiding them in their assessment. The card set included images of each louvered door design – both open and closed – mapped onto each interior style, helping participants realistically visualise the louvered door design in context. Then with *follow-up interviews*, the participants were asked to rank each design in terms of aesthetics and suitability for different interior styles.



Figure 7: Visual tool kit

2.4 PRODUCTION AND ENGINEERING FEASIBILITY TESTING

The same prototypes were also used for *expert testing and interview* (Fig. 8) on materials and production process, installation, maintenance, durability and repair-ability. Participants in this section needed to have knowledge and experience in architecture, interior, contractor, product design and engineering, furniture design, and production. Four experts were invited to participate in this assessment activity. Each expert was asked to investigate each design in terms of cost-estimation, ease of installation, door structure and durability, ease of maintenance and repair, as well as mould- and rust-resistance. During the session, all experts were asked to demonstrate their method for installing each design, offering opinions and suggestions for improving the practicality and feasibility of design. The final process asked experts to rank the four designs with respect to the five factors mentioned above.



Figure 8: Expert testing and interview

3. RESULTS

The testing results are in two measurement formats. The first format is *quantitative* – the ranking order showing the performance level of each design towards each assessment factor. The second format is qualitative – taking participant opinions regarding design from interview data. A *frequency distribution analysis method* was used to analyse data for ranking. Qualitative data from all participant opinions was summarised and used for confirming the results of ranking as well as giving more insightful information. Given that *the materials and louvered blades in all designs are the same*, the analysis of testing results in all 3 aspects – energy saving, human dimension, as well as production and engineering – can be concluded as follows:

3.1 ENERGY SAVING

As the materials are of the same type, thermal conductivity is not considered a variable here. The variable of most concern in energy saving is leakage through each louvered door. Please note that leakage is a key factor simply because hot and humid *fresh* air is a significant burden on cooling load. Results from air leakage experiments affirmed that the best model for preventing air leakage is design C. However, the average velocity of air leakage for design A, B and D did not differ significantly from that of design C (Lehtonen et al. 2008).

3.2 THE HUMAN DIMENSION

3.2.1 Ease of louver open-close operation

Design C is the most convenient to open and close because participants described it as easy and effortless to operate. Design D is ranked second as it can be conveniently opened and closed both neatly and tightly. Participants did however feel that the inside mechanism used in design D remained heavy and needed a lot of effort to lift and pull, possibly rendering it unsuitable for children and the elderly (Lehtonen et al. 2008).

3.2.2 Ease of cleaning and maintenance

Design C proved easiest to clean due to fewer parts and a less complex mechanism when compared to the other door designs. However, its design did need to be cleaned more often, since its slats were exposed. Moreover, the slat controller proved quite difficult to clean due to its location on the door. Design D ranked second as when it was compared to design C, the groove and crevice parts were more difficult to clean, especially the niche overlap between the opening and closing. However, if most of the time the vents are closed, design D is unlikely to have much dirt and should not need to be cleaned often (Lehtonen et al. 2008).

3.2.3 Privacy

Participants felt that the double-door structure of design B can prevent users from being seen or heard by someone on the other side of the door which lead to an increased sense of privacy. Design A and D were ranked second as their slats can only be closed and open from the inside. Participants experienced a greater sense of privacy as people outside cannot open the door slats (Lehtonen et al. 2008).

3.2.4 Security

Design B has the strongest structure giving it the highest sense of security. The possibility for breaking in is significantly reduced as it is difficult to tamper with its interior sliding mechanism. This makes design B suitable for installing between the inside and outside areas of a house. A solid panel with a locking mechanism inside design D works like a double door making participants feel safe as people from the outside would not be able to break in easily. However, due to large vents, insects and small animals could pass through easily if vents were to be left open. To solve this problem, the installation of an insect screen for Design D was highly recommended (Lehtonen et al. 2008).

3.2.5 Aesthetics and suitability to various interior styles

Design D has the highest rank for its beauty and suitability to various interior environments. Most participants liked this design as it looked simple and mellow and could easily be co-ordinated with a variety of interiors. As the ventilation pattern itself works graphically, the pattern differentiates the door from other typical louvered doors on the market. Design C also works well in classic, elegant and warm styles (Lehtonen et al. 2008).

3.2.6 Resident preferences

Following testing, when asked which door participants would most like to be installed in their homes, design D was the one most selected as both an inside and outside door (Lehtonen et al. 2008).

3.3 PRODUCTION AND ENGINEERING

3.3.1 Cost of production

Design A has the lowest cost of production while the production cost of design B, C, and D increase accordingly (Lehtonen et al. 2008).

3.3.2 Ease of installation

Only design A and B are possible to install to an existing louvered door, it is however quite a complicated process. Design C and D can only be installed as new doors (Lehtonen et al. 2008).

3.3.3 Structure and durability

Design B has a strong to very strong structure in both open and closed positions. Due to a sliding mechanism, the door does not have any moving mechanical parts that are easy to break. Nevertheless, this condition will depend on the quality of rails and installation process. Design D has a moderate to strong structure. This design does however need to be produced as a completely new door from the factory. Additionally, some fragile mechanisms hidden inside the door may be at risk of fracture during distribution and transportation. Design C has moderate to poor structure because there are many moving parts when opening and closing the adjustable slats. Moreover, the rubber seal at the edge of the slats may work loose and deteriorate after a certain period of time (Lehtonen et al. 2008).

3.3.4 Ease of repair and maintenance

Design A and B are relatively easy to repair and replace parts. Design C is moderately easy to repair as the mechanism and components can clearly be seen from the outside. Design D has the lowest ranking as this door has not been designed for disassembling prioritising instead strength and security. Should a problem with the internal mechanism of this door arise, exchanging the old door for a new one would be an easier solution than repair. However, the mechanism which is completely immobile does have an advantage. It makes it harder to damage and does not require frequent repair when compared to the other doors with external mechanisms (Lehtonen et al. 2008).

3.3.5 Mould- and rust-resistance

Design C has the best mould- and rust-resistance due to a louvered system that can be fully opened. This renders it easy to clean and minimises moisture. Although design A and B have quite similar structures, design A can prevent accumulation of mould and rust better than design B because design B has a rail section with narrow grooves that retain moisture. Furthermore, if the door were to be made of wood, any resulting swelling and bending of the rails could easily cause difficulty to

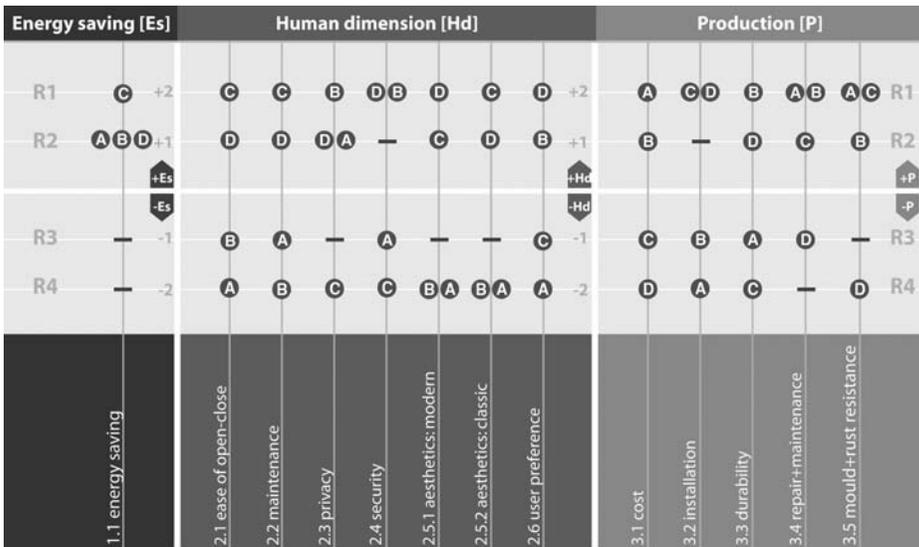


Figure 9: EsHdP framework used for evaluating all of the louvered door designs proposed during the project

its operation. Design D is the least efficient regarding rust and mould prevention. Most of this product's complex structure and mechanism installed inside could face similar problems. The process for moisture ventilation is more difficult than in other designs. In order to prevent rust and mould, design D requires a solution that will ventilate moisture without further compromising its structure and strength. Therefore, as design D stands, no matter what material it is made from, it cannot be used externally where high humidity is present (Lehtonen et al. 2008).

4. REFLECTIONS ON THE RESULTS

The testing results reveal that the design that achieves the best performance with respect to energy-saving is not the same design that is most suitable to user needs and behaviour, neither is it the same design that is most feasible in production and engineering. Furthermore, testing results are in various measurement formats – *quantitative* results for velocity air leakage testing as well as human dimension and production ranking, and *qualitative* results from user and expert interviews and observation. Converting all data into ranking-results helps to put all information onto the same platform. Results can thus be more readily compared. In view of that the *EsHdP framework* (Fig. 9) was created to assist in analysing possible design directions from testing results, evaluating these directions and choosing one or more designs most likely to fulfil the objectives of the project.

As shown in Fig. 9, the horizontal axis contains all design criteria in each category including energy saving (1.1), human dimension (2.1-2.6), and production (3.1-3.5). The vertical axis is in scale of rank (R1 = 1st rank, R2 = 2nd rank, R3 = 3rd rank, and R4 = 4th rank). R1 and R2 refer to the efficiency of each design relative to a particular criterion, so the value is on the positive scale (R1 = +2, and R2 = +1) while R3 and R4 refer to inefficiency of each design relative to particular criterion, so the value is on the negative scale (R3 = -1, and R4 = -2). This assessment framework used in this project can be applied to other architectural and product design projects focusing on *energy efficiency*. However, the assessment criteria within each category should be adjusted accordingly depending on the nature of the project and the users. After ranking all design directions on the framework according to the testing results, all values – both plus and minus – for each design in each category are summed-up. The sums are then used to evaluate how well each direction has performed relative to the design criteria for each category. As mentioned earlier, energy saving, human dimension, and production are essential factors for the success of energy-saving design. Ideally the most promising design that will be selected for further development should be positioned on a positive scale in all criteria. However, in many cases, the assessment results may not be as ideal. As energy efficiency is the main focus of the project, the efficiency result of energy saving of the selected designs for further development has to be positioned on a positive scale, which is in the (+Es) section. Furthermore, without appropriate human dimension, an energy-saving design will never have the chance to perform energy-efficiently since no one would like to possess an unusable or undesirable product. And even when owning a louvered door, an owner may prefer not use it to aid in energy efficiency as intended because it does not suit their personal behaviours. Therefore, the efficiency of selected designs in the human dimension category also has to be on a positive scale, which is in the (+Hd) section. On the contrary, production of the designs proposed can be easily refined by design and engineering to meet the criteria such as changing materials or adjusting production processes. Therefore the efficiency of the selected designs in this category can be either on a positive scale (+P) or negative scale (-P). Hence, any design that passes the EsHdP assessment and is brought forward for further development has to match one of the two assessment options, which are (+Es)(+Hd)(+P) or (+Es)(+Hd)(-P).

As shown in Fig. 9, regarding performance in energy saving, design C is ranked first (R1), receiving +2 points. From a calculation of all factors, the results of each design are as follows; design A (+Es: +1)(-Hd: -9)(+P: +3) and design B (+Es: +1)(-Hd: -2)(+P: +5) have a positive scale in all categories except the human dimension category. This means that design A and B do not pass the EsHdP assessment framework. Design C (+Es: +2)(+Hd: +2)(+P: +2) has a positive scale in all categories while design D (+Es: +1)(+Hd: +10)(-P: -2) has a positive scale in all categories except production. Therefore, design D and C should be considered for further development. Even though design C has positive scale in all design criteria categories when it comes to the decision making for their own house, most participants decided to purchase design D for both indoor and outdoor use because

design D can satisfy most of the factors adequately. Emotional factors in terms of beauty and interior style matching also play an important role in creating a good first impression and persuading purchase decisions. Given all these reasons, the team have recommended design D for further development. However, design D is still in need of development regarding resistance to mould and rust, cost effectiveness in production, and ease of repair. Furthermore, some techniques used in design C such as sealing and less effort during operation can further be integrated into design D.

5. DISCUSSION

The limitation of this research and development is that due to the given scope of the funding, the project only focused on louvered door solutions. In fact, other alternatives are also possible to provide natural ventilation and at the same time enhance energy efficiency in air-conditioned spaces, human dimensions, as well as production and engineering. In addition, sale price influencing economic success of the louvered doors and detailed designs such as louvered blade designs and material selection were excluded from the project.

Nevertheless this paper shows how interdisciplinary collaboration among specialists from various fields could lead in a promising direction with respect to louvered door design. Apparently, to achieve the design of energy-efficient architecture, design solutions should not be concerned solely with *technical* and *scientific* aspects, but must accept a need to integrate additional *human dimensions* that influence energy efficiency through practicality and acceptability by the consumer. This project exemplifies how human dimensions can play an important role in the design of louvered doors and the possibility of performing to their full capacity. In a real context where louvered doors are sold and used, the energy-efficient performance of a door will depend on several factors. For instance, the most energy-efficient louvered door, left on a hardware store shelf, will never have the opportunity of performing at all; and the slats of the most energy-efficient and good-looking louvered door, installed in a house, may end up being left open all day and night due to being inconvenient to open and close. Understanding user needs and behaviours towards design will ensure that the design solution be more *usable*, *desirable*, and *satisfying*; and lead to overall design success.

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Urban grain and the vibrancy of older neighborhoods: metrics and measures

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ABSTRACT:

As American cities focus on urban growth and increased density, they must learn to adapt and transform over time. The character of place and pedestrian vibrancy and neighborhood sustainability depends on the accessibility and proximity of services and functions in order for them to be successful. Older neighborhoods – ones that were developed before the dependence on the automobile – are our best examples of walkable, vibrant neighborhood fabric yet are disappearing at an alarming rate across American cities in the name of the a new urban density and under the premise that non ‘historic’ buildings hold little value. Neighborhoods that encompass a variety of textures, building ages and sizes that relate to pedestrian scale and walkability contribute a collective heritage and value to cities over time.

INTRODUCTION

Current trends of urbanization across the country are focusing on increased density in our cities. While the idea of living at higher densities can combat sprawl, how does this affect existing, older neighborhoods? Many new buildings built for high density lack a sense of historic character and uniqueness of place, and cover entire blocks that don’t lend themselves to a quality pedestrian experience. Density must be combined with livability if we are to make quality cities that make successful places for people. This paper presents a study that suggests that a variety of age, texture and scale in buildings inherently assert a degree of richness in neighborhoods. Preliminary results of the study suggest that fine grain buildings in a block correlate with increased pedestrian activity and therefore urban vibrancy. The research method conducted for the National Trust for Historic Preservation’s Seattle-based Preservation Green Lab in consultation with Copenhagen-based Gehl Architects, ‘urban-quality’ consultants that have led revitalization efforts in over 500 cities around the world.¹ The Gehl approach is a proven observation and survey-based data gathering methodology that is used to measure the impacts of detailed features of the built environment on pedestrian behavior in the public realm. The study was built upon the premise that older, finer grained neighborhoods also contribute to sustainable environments by reducing the need for new construction, especially in the name of urban density, by preserving and reusing what we already have. Ultimately, this phase-one of the project adapted and built upon this ideology and methodology to determine connections between causes and effects in older, fine-grained urban commercial neighborhoods.

While this study considers neighborhood vibrancy and quality, it also recognizes older neighborhoods as contributing significant environmental benefits. Preservation and reuse of our existing buildings and neighborhoods reduce the need for new material and resource consumption, minimize construction and demolition waste to landfills, and use less energy than demolishing and re-constructing new buildings. Most often in the name of density, new, denser neighborhoods are replacing existing ones at a rapid pace in urban cities across America . A recent study by the Brookings Institution reported if we continue with national trends of teardowns, by 2030 we will have demolished and rebuilt nearly one-third of our entire building stock – a staggering total of 82 billion square feet. The energy required to demolish these buildings would power the entire state of California – 37 million people – for a decade.² Rather than tearing down and rebuilding, historic buildings and neighborhoods can be upgraded with new technologies to maximize efficiency while maintaining historic integrity.

In the name of density, many older buildings and neighborhoods are demolished in favor of new, higher density construction. These new buildings are often rebuilt at a larger scale to increase density,

incorporate vehicle parking and larger stores that can attract commercial tenants, often chain stores. The result is often buildings that are out of human scale and distinct with no distinct historic texture or neighborhood character. In her book *The Death and Life of Great American Cities*, Jane Jacobs wrote “we need texture and age in our cities,”³ and promoted the need for vibrant neighborhoods that can incorporate the past as well as establish successful futures. The successful neighborhood experience is intimately tied to the small details that compose a building as well as the neighborhood block. The built environment must be of such a high quality that it supports the way that people live, whether they are sitting, working, playing, walking, talking, or eating. Older neighborhoods with a mixture of historic building types lend themselves to a sense of what can be referred to as “smallness” – or the relationship of the building to the human scale. Smaller, fine grained streets with a variety of buildings not only is sustainable through preservation of our existing resources, but also creates a more vibrant pedestrian experience.

Our bodies and senses have not changed much through modern times, and the basic needs of people remains consistent across cities, and across cultures. The human is a walking being, moving with an average speed of 3 miles per hour and experiencing life through delicate senses. The everyday world is viewed at an average angle of 72 degrees from eye level.⁴ When walking through a neighborhood, therefore, the things at ground floor—or eye level—will be most likely to hold someone’s attention. The quality, arrangement, and function of these things are crucial to the legibility of a neighborhood and to our overall impression of the quality of life. The battle for neighborhood quality is won or lost at the small scale. Successful cities rely on buildings that relate to pedestrian activity, and neighborhoods that have a variety of activates and building types, a variety of age in the building fabric and texture can be easily adaptive into new uses that retell their story for generations.

METRICS AND MEASURES FOR UNDERSTANDING OLDER NEIGHBORHOODS

This study examines the ‘urban grain’—defined as the degree to which the quantitative physical features of façades are finely mixed and various at street level. By examining and mapping the building massing, age, texture, functions, rhythm, and accessibility along with pedestrian behavior, the study attempts to assess the following questions:

- How important are scale, age/historic character and texture of ground floor façades to neighborhood success?
- Does a fine urban grain and building age correspond to a more vibrant urban experience?
- Do different user groups exhibit a discernible pattern of behavior in relation to the buildings’ physical character?
- Can a set of metrics be established to measure these qualities and replicated elsewhere?

This initial study measured the quality of urban grain and existing building stock of two neighborhoods in Seattle (Figure 1). This first phase focused on establishing a working set of metrics that could be established as a way to measure urban grain, building age and neighborhood quality in different urban settings. ‘Urban grain’, in this context, was observed on two scales: individual building and entire block. The two sites were older, historic neighborhoods that had blocks of new construction with larger scale buildings inserted within the older fabric. Since people are the primary users of our built environment, the study designed a methodology that looked at both the *physical characteristics* of the street-block, and the *physical activities* of the people-users.

STEP ONE: RATING BUILDING AND BLOCK QUALITY

The study first set out to measure the quality of the neighborhood at both the block and street level. One set of measurements rated the quality of the buildings within each street. Buildings were rated on a scale of one to five with one being a low rating and five being a high rating.⁵ Each metric was recorded then entered into a GIS database system that was set up for the study so a variety of scenarios could be pulled from the study. The first metric was *building age*, which was pulled from a GIS database from the City of Seattle. The second metric, *activity and rhythm*, measured the façade

width of the building by a single numerical measurement. The third metric, *materials, quality and maintenance*, rated the overall primary materials and the care they had been treated with over the years. This quality of maintenance can reveal many things about the building; the respect for the building by the owners, the character of the overall street through upkeep and competition, and the longevity and durability of the building itself. *Visual Quality*, the fourth building metric, looked at over all texture and surfaces. In Gehl research, the visual quality and textural interest at the human level contributes to the level of engagement by the pedestrian, and detail and texture are part of that quality. *Physical Quality* looked at the looked at the amount of openings in a building that could be either walked through (doors) or communicated through (open windows) through simple measurements of openings while transparency and visual interest measured the overall transparency, taking into account all transparency (windows and doors) that engaged the pedestrian regardless of whether they could move through them or not. These six building measurements incorporated both quantitative measurements and qualitative measurements, and focused on the individual quality of the buildings, which was then cross-referenced with the block quality measurements.

The second set of neighborhood measurements rated the overall block. Blocks were rated at one side of the street at a time, and on a scale of one to five with one being a low rating and five being a high rating. (Figures 2&3).. Once collected, the data was entered into charts and a GIS database and mapped. The first metric looked at *urban rhythm* of the street. Lively and vibrant streets have an urban rhythm that has diverse functions along the street wall and many doors, windows and openings that result in dynamic contact between inside and out. The second metric was the *fine grain* of the street, which measured how many buildings were on a given block to understand the amount of buildings in relation to the plot size. The third metric took an *average façade width* of the block, dividing the total block width by the number of buildings of the block, and the final score was the building score average, which took an average based on the overall quality of the buildings and the number of buildings on that block (Figures 2 and 3). Each of these scores were then entered into the GIS database where they could then be mapped and analyzed (Figure 4).

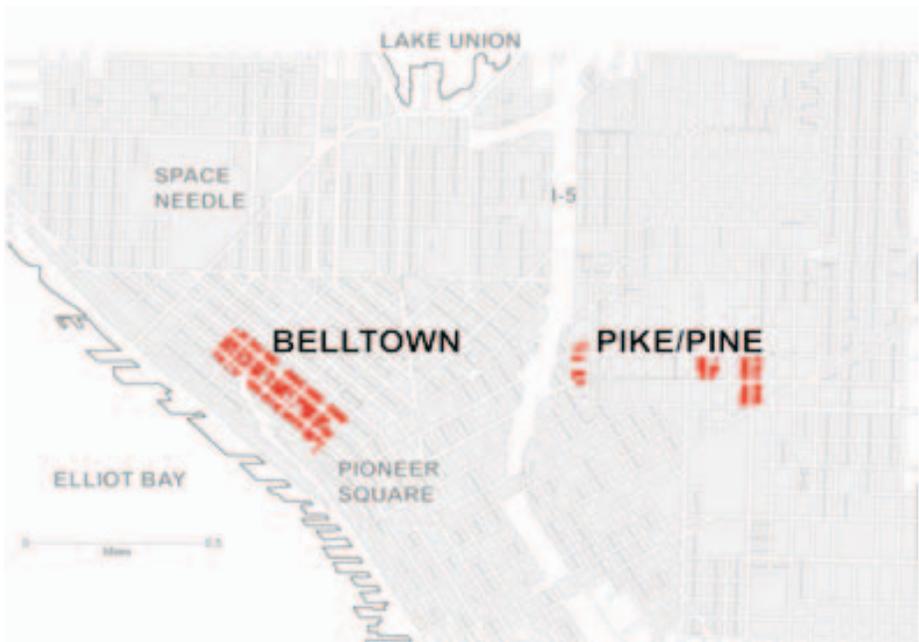


Figure 1: Areas of study in two Seattle neighborhoods, Belltown and the Pike Pine Corridor

urban grain

study summary

street metrics:

[A1] urban rhythm

Lively and vibrant streets have an urban rhythm: 15-20 units and 20-25 doors every 300 feet. Diverse functions along the street wall provide narrow units and many doors, resulting in dynamic contact between inside and out.

[A2] fine grain

Fine grain streets have a high diversity of small and medium building widths. These small frontages provide many points of exchange between inside and outside. Conversely, continuous building facades and open, empty lots lack variety and rich sensory experiences.

[A3] average facade width

Buildings with shorter facade widths result in a more dynamic street wall, with many opportunities for new functions and pedestrian engagement. The average facade width is calculated by dividing the total block width by the number of buildings on the block.

[A4] building score average

Each building on the street will given a score based on its individual characteristics (see [B6]). The average of all building scores for a block constitutes a Block Score Average based on the overall quality of the buildings and the number of buildings on that block.

[B1] age

Buildings which adapt to new functions over time and age gracefully contribute greatly to our urban environment. Through time we invest buildings with meaning and the reuse of these older structures speaks to pedestrians through memory and cultural association, as well as through the craftsmanship and detail frequently present in older buildings.

[B2] activity & rhythm

Fine grain streets have a high diversity of small and medium building widths. These small frontages provide many points of exchange between inside and outside. Conversely, continuous building facades and open, empty lots lack variety and rich sensory experiences.

[B3] materials, quality & maintenance

Materials that are of a good quality and well-maintained create a pleasant atmosphere that help pedestrians feel safe and experience the longevity of a building. A building that is well-maintained is generally treated with respect.



[1] & [2] Small units, many doors. Streets with small permeable buildings make walking trips interactive and inviting for pedestrians.
 [3] Historic buildings adapt to accommodate changing programmatic needs. This building is both memorable and malleable, built from quality materials and well maintained.



[1] Long, continuous building facades provide no interest or engagement for the pedestrian.
 [2] Poor material quality does not enrich the public realm and experience for the passerby.
 [3] Open and empty lots detract from a vibrant pedestrian environment, providing no public functions, visual interest or activity.



study summary continued

building metrics:

[B4] visual quality

The building is rich with multiple textures, either through materials or through surfaces. Details and varied visual experiences create an engaging and enjoyable pedestrian environment.

[B5] physical quality

When a building extends activity into the street (either through operable openings at the ground level or through utilizing space adjacent to facade), the pedestrian is automatically engaged through multiple sensory experiences. A building that relates to human scale and breaks up the facade vertically and horizontally, creates a rhythm for the pedestrian to follow.

[B6] transparency & visual interest

A high degree of transparency allows for a healthy relationship between inside and outside. Pedestrians take part in the activity within a building through this visual contact. Transparency in a building at ground level engages pedestrians.



Figure 2 and 3: Street Metrics A1-A4 and Building Metrics B1-B3, Street Metrics A1-A4 and Building Metrics B1-B3, Building Metrics B4-B6



Figure 4. GIS maps illustrating [B1] Building Age, [B3] Building Materials and [B7] Building Average, Source: (Author, 2010)

STEP TWO: MEASURING PEDESTRIAN ACTIVITY

The next set of metrics counted pedestrian use. Understanding how people use the public realm helps understand and define what makes successful streets. Public life is composed of understand how people use space in and around the street and buildings. For this portion of the study, two types of measurements were taken; moving pedestrian counts and static pedestrian counts. Data for both was gathered on pedestrian activity at regular intervals and recorded on maps, and recorded to measure the interaction between pedestrian activity and building quality. Results were entered into a GIS database, which was turned into a set of graphics that could illustrate the results.

The first set of measurements counted moving pedestrians through the street. Researchers stationed themselves at one end of the street for 30 minutes both morning and evening, weekend and weekday, and imagined a laser line running across the sidewalk in one location (Figure 5). For each pedestrian that crossed the line in either direction, a count was recorded using a clicker. Counts were taken by pedestrians only, no wheels (bikes, strollers) were counted. Data was assembled and entered into the GIS database (Figure 6).



Figure 5: Moving Pedestrians were counted as if moving through an imaginary line (Source: Gehl Architects 2010).

The second set of people measurements measured how people interacted with the building façade; whether pausing/standing, entering/exiting or sitting. Mapping of stationary pedestrians occurred by standing at the same location as moving counts, for 30 minute intervals, morning and evening, weekend and weekdays. Researchers gathered data at both end of the streets and recorded pedestrian activity entering and exiting buildings, standing, pausing, leaning and sitting. Each of the movements were recorded on maps with notations (Figure 7), and then graphically expressed next to the building and street data through diagrams (Figure 8). Each figure represents exactly one pedestrian in each drawing, the shade corresponding to their activity. This set of diagrams were the most revealing in comparing the specific quality and quantity of pedestrian activity to the quality of building and block data (Figure 9).



Figure 6: Moving pedestrian counts were entered into the GIS database Source: (Author, 2010)

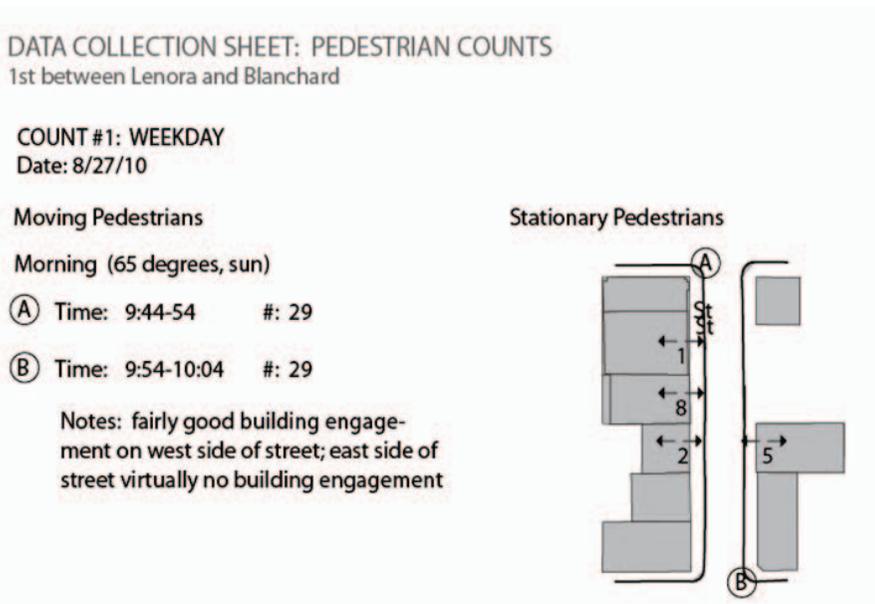


Figure 7: Data illustrating the moving pedestrian counts and how they were recorded Source: (Author, 2010)

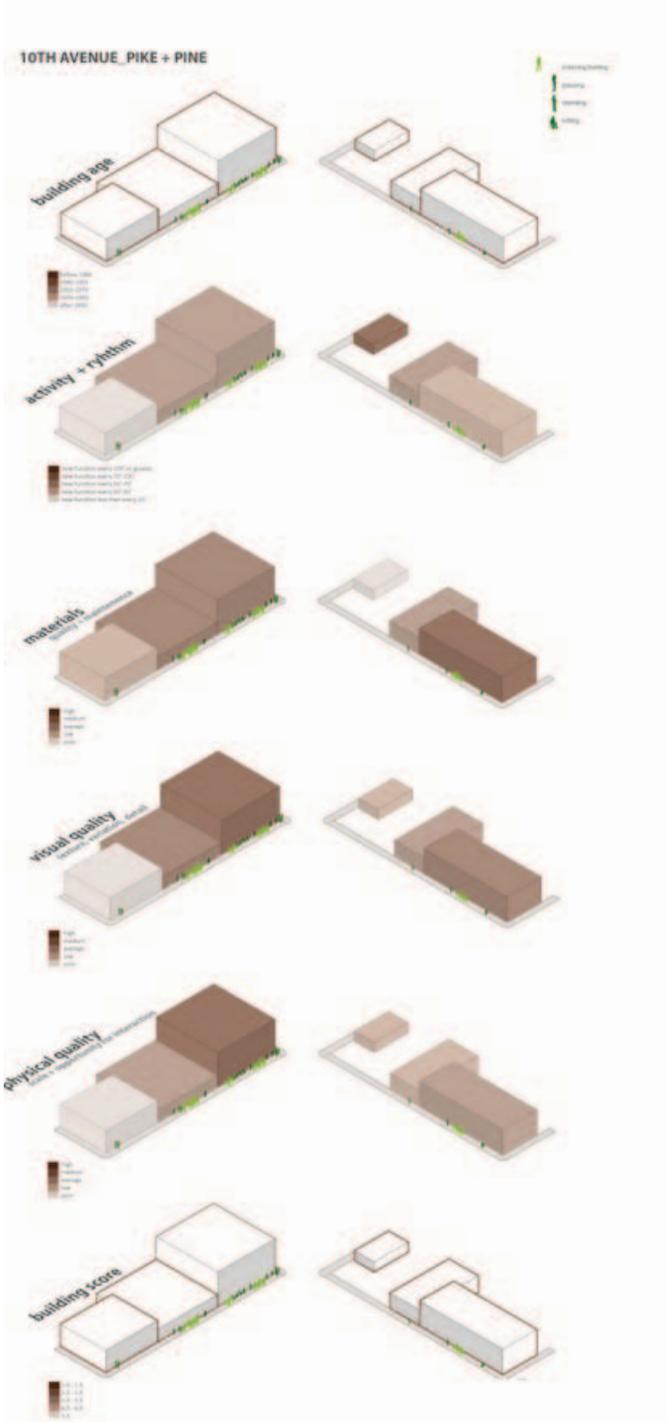


Figure 8: Diagram of a block with all ratings and stationary pedestrian counts included. Each figure represents one pedestrian, and the shades represent corresponding activity (Source: Author 2010)

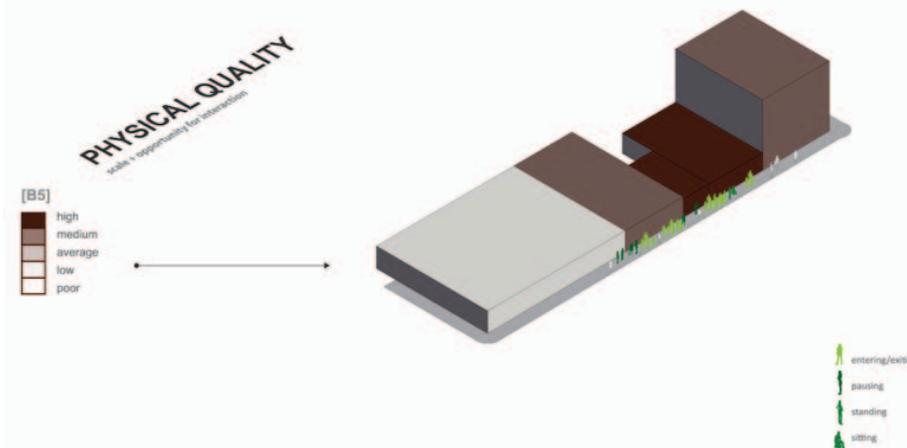


Figure 9: Diagram of a block with building rating [B5] and stationary pedestrian counts included. Each figure represents one pedestrian, and the shades represent corresponding activity Source: (Author, 2010)

CASE STUDY: 12TH AT PIKE AND PINE

The Pike Pine Neighborhood is an eclectic low-rise neighborhood just east of downtown Seattle. In 1998, the neighborhood created design guidelines out of concern for the scale of downtown development creeping into the neighborhood. In recent years, despite the current zoning and design guidelines, development pressures have begun to accelerate changes that alter the character of the neighborhood including the demolition of the existing building stock and construction of new buildings out of scale with the urban grain. Like many developing neighborhoods in Seattle and across the US struggling with new urban population growth, the community is balance the desire for density and development with that of physical and cultural continuity in order to accommodate the need for increased residential and commercial capacity. This context made it a good urban studio for the measurement of urban grain and neighborhood vibrancy.

The Pike/Pine corridor has an eclectic mix of older buildings, many of which are vernacular with no formal historic designation. Of a total of 278 buildings within the Pike/Pine study area, 165 (59.4%) are more than 85 years old. Forty-six buildings (16.5%) were built between 1923 and 1945, 51 (18.3%) were built between 1946 and 1995, and 16 (5.8%) were built from 1995 to 2007.2 The Pike/Pine neighborhood developed as a commercial corridor just east of downtown Seattle and south of the Capitol Hill neighborhood. Through there were residences early on, the neighborhood quickly became a commercial hub of automotive uses known as “auto row” in the early part of the 20th century. The automotive uses established a collection of distinct building types consistent to the neighborhood. The open span 1-4 story concrete and brick buildings held auto-related showrooms, offices, repair, and parking. The open structural bays framed large industrial windows along the street letting in light (along with skylights) and establishing high visibility into the businesses. Over the years some of the automotive uses left and were readily converted to office, retail, and residential uses, though many still define the neighborhood. With the construction of 1-5 in the 1960s, the neighborhood began to decline, but became more populated starting in the late 1970s/early 1980s, and accelerating in the 1990s. Substantial population growth between 1990 and 2007 (21.3%), accompanied by a similar increase in the number of housing units (21.2%), shows its conversion to a mixed use neighborhood, with a large population increase projected for the next twenty years.

Of the many streets studied for this research, the block between Pike and Pine on 12th Avenue summarizes preliminary findings the study most clearly (Figure 10). As seen in the diagrams that combine building and street metrics with pedestrian activity, the east side of 12th was the more utilized and active side of the street (Figure 10). As traffic flowed from all four corners of

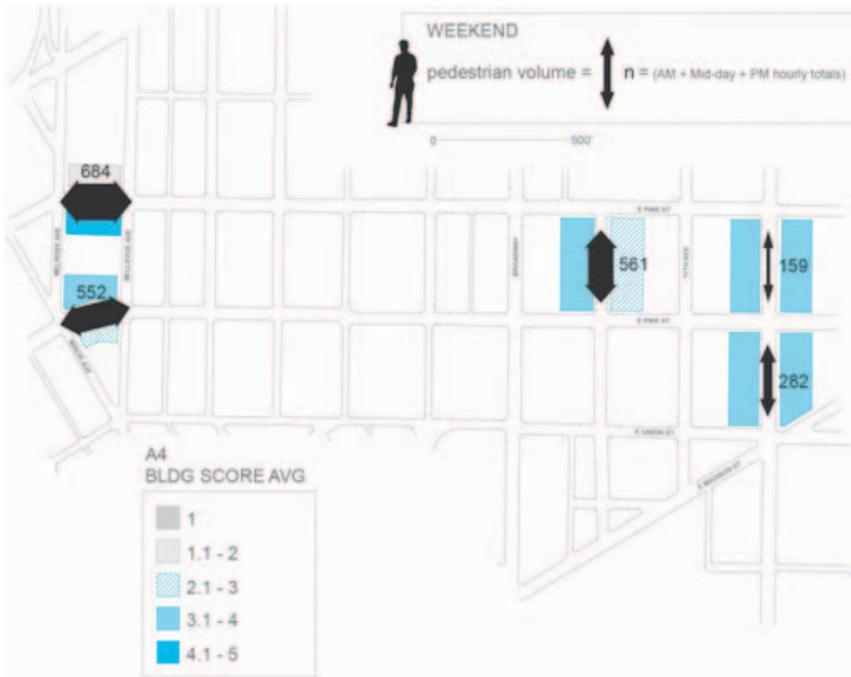


Figure 10: A sample GIS map with moving pedestrian count traffic overlaid on overall block ratings Source: (Author, 2010)

the block, pedestrians tended to cross to the western side to move through the street. Even though both sides of the street were filled with similar functions, the west side with older buildings, finer grain and narrower lots had 46% more pedestrian activity sitting, standing, entering and exiting and pausing on the street. This block also rated highest for granularity, fine grain and older building age. Surrounding streets and metrics taken in the second Seattle neighborhood, Belltown, revealed this was the case in the majority of the streets measured.

These preliminary results indicate that better textured, aged and finer grained streets provide more interesting routes and street activity. Building texture of older buildings provides good sensory experiences through wealth of details and quality of materials, and varied surfaces are permissive in that they invite sensorial interaction. In addition, façade transparency at ground level is a critical determiner of street activity. Pedestrians are often more comfortable knowing what happens inside the buildings they walk past while people inside can passively survey the sidewalk, making for a street that is experienced as safe. Furthermore, the more visual connections between people inside and outside the buildings, the greater the opportunity for social exchange fostering social capital building, a stronger sense of place, and connections within the community at large.

While the east side of the street measured relatively high due to the quality of new construction, it clearly was less occupied – even during the afternoon hours when the building had better quality sunlight. As a newer building, two items rated the building on the low side: building quality and texture, and activity along the street. As seen in the image, the building in the center takes up over 50% of the street façade with a continuous façade of new construction, which in age, grain and texture, rated much lower than its older peers. These characteristics were typical of newer projects which were out of scale with the older fine grained buildings that the made up the historic neighborhood (Figure 11). What did not seem to affect ratings were measurements of material quality, visual quality and transparency, as these can be more integrated into new and older buildings.

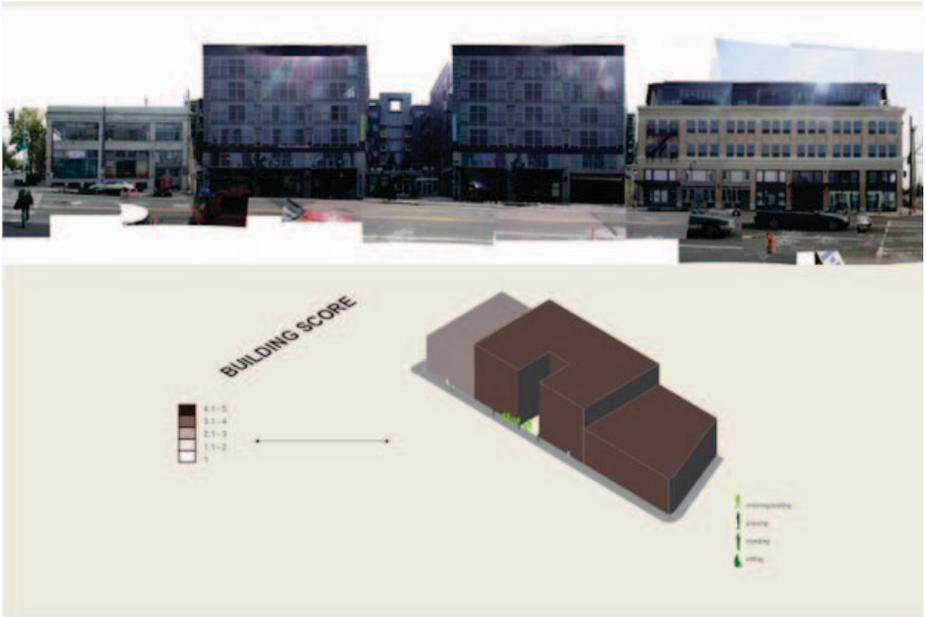


Figure 11: The east side of 12th in between Pike and Pine showing the new building with a relatively high score of building quality in regards to materials, transparency and functions, but a much lower pedestrian count Source: (Author, 2010)

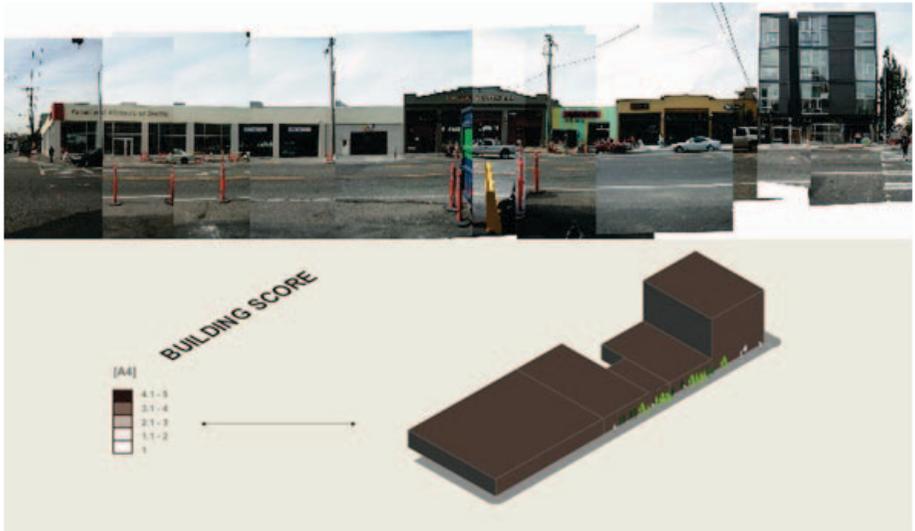


Figure 12. The east side of 12th with new and old buildings that retain the small urban grain. Even though both sides of the street were filled with similar functions, the west side with older buildings and narrower lots had

CONCLUSION AND FURTHER STUDY

While this study is ongoing, preliminary results of the study provide quantifiable data that suggest a finer grain block with older building ages corresponds to increased pedestrian activity and street vibrancy. Higher ratings were found on blocks that had shorter average building widths that corresponded with older buildings and more durable materials. Blocks that had long, continuous building facades appeared to provide no interest or engagement for the pedestrian, nor did blocks that had open, empty lots, or buildings with poor material quality. As a form of trial and error, many further adjustments in the methodology will be made. Some of these include using a broader study area; recording where bus stops were located; recording business typologies and differentiating between local and chain retail businesses.

While much more analyses of the data and testing needs to be done, the study provides insight into the usefulness of building and pedestrian data and how they can help understand and communicate what makes successful and vibrant urban neighborhoods. In addition, GIS data mapping tools and descriptive graphics provide a dynamic and innovative research tool in assessing and illustrating this information. Further research will include pedestrian demographics, economic data and transportation comparisons. If developed further, these metrics may be useful to help preserve older existing neighborhoods with finer grain in the face of demolition to satisfy urban density development. While density is an important part of our sustainable urban future, livability and quality historic neighborhoods must also exist for a more successful urban future.

ENDNOTES:

1. <http://www.gehlarchitects.com>
2. Patrice Frey, "Making the Case: Historic Preservation as Sustainable Development" (National Trust for Historic Preservation, 2007).
3. Jane Jacobs, *Death and Life of Great American Cities*. (Random House, Inc. New York, 1961).
4. Jan Gehl, *Life between Buildings* (Copenhagen: Danish Architectural Press, 2003).
5. The study was conducted with a set of baseline measures so the outcome would have consistency

SELCO Credit Union: a case study in quantifying the environmental impacts of design for deconstruction

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ABSTRACT:

Architect Daniel Herbert designed the SELCO Credit Union in Eugene, Oregon in 1972 to maximize the amount of material that could eventually be salvaged for re-use or recycling at the end of the life of the building. While there are no immediate plans to take the building down, this paper uses the current environmental value of the building material and current local building deconstruction and material recovery practices to conduct a speculative analysis of the environmental consequences of the architect's intention to design for eventual deconstruction.

To conduct this analysis, we asked and then investigated the following questions: 1) Based on international carbon and energy factors for each of the building materials, what is the environmental value in terms of embodied energy and carbon of the quantities of building materials used? 2) If the building were deconstructed today, what parts of the building could be diverted from the waste stream for direct reuse, what could be recycled into new materials, and what would be sent to landfills?

By categorizing quantities of building materials by degree of recovery and by cradle to gate carbon and energy impact, we estimated that more than one third of the embodied energy and about one third of the carbon embodied in the existing building could be recovered. Much of this savings can be attributed directly to three of the architect's decisions: 1) To build with a panelized plywood roof system, 2) To use uniformly sized concrete panels that can be disassembled, and 3) To use bolted trusses of high-value timber. We can conclude that if this case study building were deconstructed today that the architect's decision to design for deconstruction would result in measureable resource savings.

CONFERENCE THEME: On Measurement

KEYWORDS: deconstruction, construction, energy, carbon, lifecycle

INTRODUCTION

Materials that go into the construction of a building are almost always used just that once. When a building is conventionally deconstructed or demolished, its materials are landfilled or downcycled as scrap metal or fuel along with the energy, greenhouse gases, and other environmental impacts that are embodied in those construction materials. But when building materials are salvaged and reused, environmental savings can be measured in terms of the embodied environmental impacts of those materials as they substitute for equivalent measures of newly extracted and manufactured construction materials.

In the US, the amount of material that is salvaged for reuse or recycling at the end of the life of a building varies by project. To increase the amount of material that could eventually be recovered from the buildings they design, architects can plan for the recovery of construction materials by designing for the building's deconstruction into reusable, high value parts. In this study, we look at such a building to evaluate the potential impact of the architect's decision to design for maximum building material reclamation.

I. THE SELCO BUILDING

Eugene architect Daniel Herbert designed the SELCO Credit Union building in ways that he hoped would maximize the amount of material that would be recouped or recycled at the end of the life

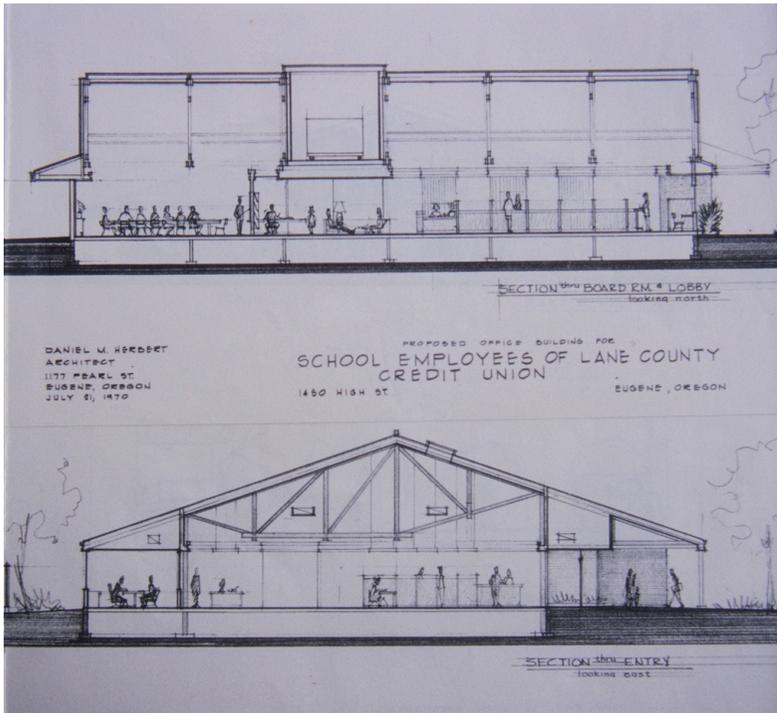


Figure 1: Architect’s drawings of the 1972 SELCO Credit Union building. Source: Daniel Herbert

of the building.¹ He chose to span the open floor plan with large bolted timber trusses to optimize flexibility of the space over time and so that the roof framing might eventually be dismantled and the timber saved. He specified precast, insulated panels for the walls that are doweled and mortared in place so that they would be easy to remove and to reuse. The roof framing and cladding is panelized and each panel is bracketed in place with the idea that the panels may be removed in whole pieces.

Nearly forty years later, the building is now operating as the Pacific Continental Bank. The current building looks a little different from the original version—the interior has been re-partitioned, the furnishings and carpet have been changed and the exterior that was originally cedar shingles is now painted board. But, the primary building systems remain the same. While there are no immediate plans to take this building down, in this paper we ask the speculative question: Given current practices in deconstruction and given the current environmental impact of equivalent replacement materials, how can we estimate the environmental impact of the architect’s decision to design for deconstruction?

2. ESTIMATING ENVIRONMENTAL IMPACTS OF CONSTRUCTION MATERIAL

2.1. INTRODUCTION

There are environmental impacts associated with the raw material extraction and the manufacturing or production of all building materials. A complete lifecycle assessment or even a “cradle to gate” environmental impact study would include various indicators: total energy used in extraction, processing, and manufacturing, carbon emitted, water used, resulting human or environmental toxicity, acidification, or eutrophication. In this case study, we do not presume to do a true lifecycle assessment of these building materials. Instead, we estimate the environmental impact replacement cost of the SELCO building materials in terms of embodied energy primarily and embodied carbon secondarily to generate a working estimate of the potential environmental savings of recouping some of the materials at the end of the life of the building.

In this case and in environmental terms, the replacement cost of the building materials can be measured in terms of the current value of the materials. Each unit of building material salvaged from this building and reused elsewhere represents a unit of building material that will not have to be extracted and manufactured. As an illustration of this premise, imagine someone who is using a bowling ball that was manufactured decades ago and who, for some inexplicable reason, drops her ball into Lake Erie. That decision costs her the price of buying herself a new bowling ball. The price she originally paid for it is no longer important. In this study, we use the same reasoning to apply environmental value to used building materials. While each measure of material had some environmental cost associated with its original production, we are concerned now with the cost of replacing it and, by extension, with the environmental value of not having to replace it.



Figure 2: Installing prefabricated SELCO Credit Union building roof panels, 1972. Source: Daniel Herbert

2.2. METHODOLOGY

In this paper, we estimate the environmental value of the SELCO building materials by estimating the quantity and type of materials in the building and then associating those materials with factors derived from current global manufacturing processes for the embodied energy and carbon for comparable materials per unit of weight. To quantify the materials, we used original construction material lists from student projects that were conducted under the architect's direction in the 1970s, construction photos, and discussions with the architect.

For clarity and in order to focus on the architect's building-scale design decisions, this estimate includes only the structure and enclosure of the building itself. We include the dimensional lumber and plywood in the building structure and enclosure, the concrete in the panelized walls and foundation, the perimeter insulation in the concrete walls, gypsum board, dropped ceiling, and the exterior doors and windows. We do not include site materials including gutters and do not include interior partitions, doors or finish materials that are changed out over time. For clarity of the study boundary we also do not include building fixtures such as for plumbing, lighting or HVAC, furniture, fasteners, or the bank safe.

For embodied energy and carbon associated with the building materials, we used factors from the University of Bath International Carbon and Energy Database (ICE), except where as noted. We do have access to other more detailed libraries of LCA data for Europe, including for North America, but chose to use the ICE because of its accessibility to architecture students. While the ICE is based on

data from the United Kingdom, a quick comparison with other sources showed us that geographical variation was statistically insignificant in the context of this study.

At the same time, it should be noted that these numbers do not account for transportation to the site from the manufacturing plant and that there are regional differences in the amount of energy and carbon embodied in certain materials, especially due to different fuel splits for manufacturing processes in different regions. For example, we assume lower carbon emissions per unit of energy produced in the northwestern US in general. But, we cannot assume in this case that replacement building materials would be manufactured in this region.

2.3. FINDINGS

In compiling the construction material and their associated carbon and energy, we estimated that the cast-in-place and precast concrete make up the majority of the building by weight (79% of the total) but in terms of embodied energy, we estimate that the energy associated with the aluminum in the ceiling grid and exterior doors and windows (43%) is more significant than that of the concrete (23%). The energy associated with the dimensional lumber is roughly equivalent to that of the concrete. This is probably heavily influenced by the amount of energy used in the extraction, refinement and manufacturing for aluminum extrusions in door, window, and ceiling systems.

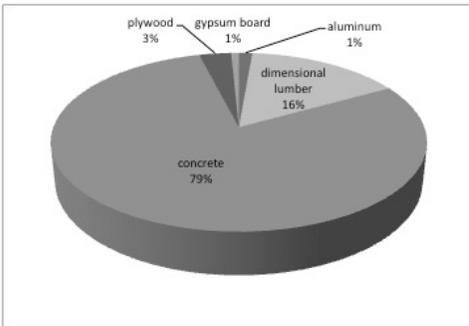


Figure 3: Distribution of Building Materials by Weight.

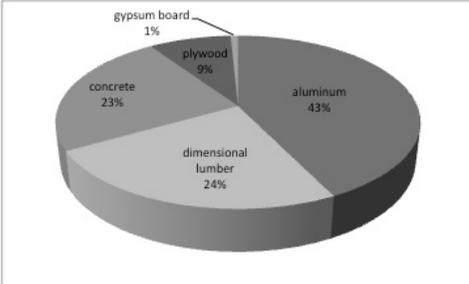


Figure 4: Distribution of Total Building Material (replacement) Embodied Energy.

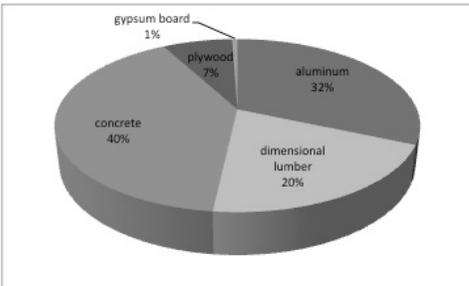


Figure 5: Distribution of Total Building Material (replacement) Embodied Carbon.

In the current environmental context, it is important to look also at the greenhouse gas emissions generated by different energy sources. In this analysis we also include the associated embodied carbon emissions for each of these materials. Because there are different fuel types with different levels of emissions associated with different building material manufacturing processes, the estimates of embodied carbon do not follow those of the embodied energy directly. In fact, this difference would vary depending on the manufacturing region.

In this case, there are proportionally more carbon emissions associated with the concrete products in the SELCO building than in any other material category (40%) followed by that of the aluminum (32%). This appears to be due to the higher level of coal (and so proportionally higher level of carbon emissions) used globally in the manufacture of portland cement compared to emissions from the generation of electrical energy used for the production of aluminum building products.

If the materials of the SELCO building were manufactured today, we estimate that they would represent about 3,350,000 MJ of energy. To translate this very roughly into more tangible terms, this is more or less the amount of energy required to make a roundtrip from Seattle to Miami in a station wagon one hundred times.² The total carbon emissions associated with the construction materials, 235,000 kg or 235 metric tons, are approximately equivalent to the amount of carbon that 5 acres of US pine forests could sequester in 40 years (EPA).

3. SPECULATIVE DECONSTRUCTION

3.1. INTRODUCTION

The environmental cost of disposing of single-use building material is large. The US Environmental Protection Agency (EPA) estimated that in 2003, 154 million metric tons (170 million tons) of building related construction and demolition material was produced. In US terms, this represents 1.45 kg (3.2 lbs) of C&D waste per person per day. (Guy). It should be noted that construction and demolition (C&D) waste—scraps, packaging and unused material from new construction and the waste from whole building demolition—are typically measured together but that it is generally understood that demolition waste in the US typically makes up 90% of C&D waste.

If the SELCO bank building were deconstructed today, how much C&D waste would be produced? How much of the building material might be salvaged for recycling or use? What are the environmental savings associated with reclaiming that material? There are three scenarios that we can imagine for the end of the life of this building: 1) In the most extreme case, the building and its material could be entirely demolished and landfilled. This classic “wrecking ball” scenario is extremely unlikely because of the local cost of dumping. In the increasingly rare locations where there are minimal or no disposal fees, it might be easiest and cheapest to do this. In the City of Eugene, the cost of whole dumping is prohibitive enough to warrant some material reclamation (Filip). In scenario 2): If no attempt were made at on-site deconstruction and material recovery, most of the building materials would be transferred in roll-off containers to a local material recovery facility (MRF) where a portion of materials with some easily recoverable value would be separated—first the scrap metal for sale to a foundry, then the lumber for hog fuel (biomass). The remainder of the material would be sent to a dry construction landfill. Our local MRF Ecosort, currently aims to reclaim 25-30% of each container, the percentage required to receive a discounted tipping fee at the landfill for the remainder of the demolition waste (Ritz). In this paper we focus on the final scenario 3): If some labor were invested in deconstructing the building, what is the *maximum* amount of material that could be salvaged for recycling and/or reuse? While in current economic conditions here, this would require additional investment in the cost of labor, this is not unlikely in the increasing number of jurisdictions where the disposal of construction waste in landfills is very expensive or prohibited and is a very conceivable future scenario for the City of Eugene.

3.2. METHODOLOGY

In order to estimate which materials would be reused, recycled, and wasted in scenario #3, we relied on our own familiarity with construction details and on the expertise of Julie Daniels, executive director at BRING, a Springfield, Oregon organization that resells salvaged building materials and that was licensed as a deconstruction contractor. We asked Daniels to help us speculate on the deconstruction of the SELCO building and to determine which materials could practically be salvaged for reuse, which could be recycled, and which would be irrecoverable.

By referring back to the embodied energy and carbon we associate with each group of materials, we are able to estimate, in degrees, the energy and carbon associated with the landfilled, recycled, and reclaimed material. This methodology is most useful for understanding the significance of the reclaimed and landfilled material.

In the case of the reclaimed building materials, this represents a savings—the amount of energy not consumed and carbon not emitted as these materials displace other materials that would otherwise be produced. In the case of the landfilled material, these quantities of energy and carbon represent a dead end loss—a lost opportunity quantified in the amount of energy and carbon that will be consumed and emitted as these materials are replaced in the building materials stream.

It is difficult, if not impossible in this case, to estimate the amount of energy and carbon emissions saved in the recycling of building parts because it is unclear how much of those two embodied impacts would be recovered in the process of recycling. For example, the aluminum doorframes sent to the foundry mean that nearly that much less bauxite will be extracted to make new extrusions. At the same time, a notable amount of energy will be used to process the recycled aluminum. In this study we do not attempt to quantify the energy and carbon savings from recycling.



Figure 6: End of Life Distribution by Weight

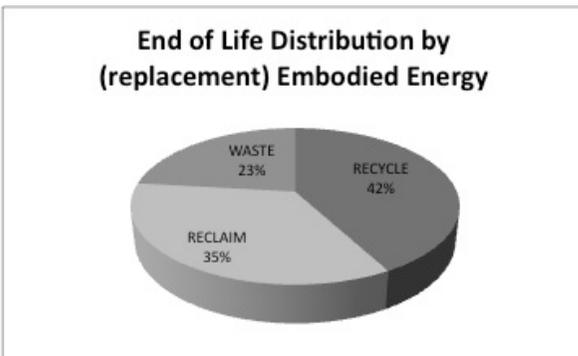


Figure 7: End of Life Distribution by Embodied Energy

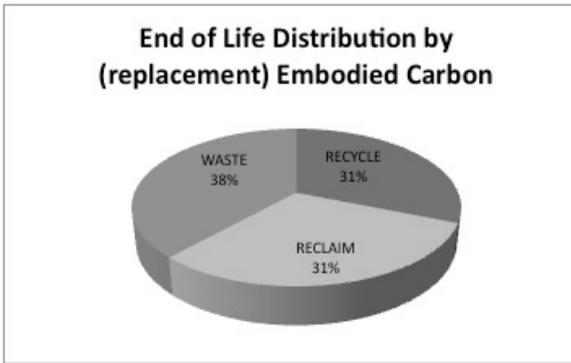


Figure 8: End of Life Distribution by Embodied Carbon

3.3. FINDINGS

According to Daniels, a significant portion of the building materials would be irrecoverable: the poured-in-place concrete, gypsum board, glass windowpanes, and acoustical panels would go to the C&D landfill. Three noteworthy building components might be able to be sold whole directly from the site for reuse: the bolted timber trusses, the roof panels, and the concrete precast panels. This depends on an interested buyer but Daniels speculated that this would be quite likely. Generally, lumber and plywood could be reclaimed for reuse or for resale at the BRING store. The aluminum door and window frames and ceiling grid would be resold to a foundry for recycling.

In our estimate, the material designated for reclamation represents 35% of the total embodied energy of the project. Of this material, the dimensional lumber, plywood sheathing and the concrete panels represent the largest amount of embodied energy and savings; the lumber has a replacement value of 23% of the total embodied energy of the project. It is interesting to note that the three major decisions in designing for deconstruction—the trusses, the wall panels, and the panelized roof system make up more than half of the reclaimed material in terms of embodied energy and carbon.

The material designated for landfill represents only 23% of the project total in terms of replacement embodied energy. This is almost entirely the poured-in-place concrete for the foundation. The broken up concrete would probably go directly to the C&D landfill but would be set aside for use in earthworks for the landfill or for use later as roadbed. While this is still a form of salvage and re-use, we do not count the embodied energy from the material as reclaimed because it does not act as a substitute for newly poured concrete.

The material designated for recycling represents a replacement value of 42% of the project total in terms of embodied energy—the largest fraction because of the large amount of embodied energy in aluminum materials. But, as noted in the methodology, this number does not translate directly into savings or loss of the environmental value of the materials.

CONCLUSION

While the most obvious savings in terms of material investment is to continue to use the building as it stands rather than to replace it, these estimates quantify significant environmental savings that could result from the architect’s decision to design the SELCO Credit Union building for eventual deconstruction, particularly in terms of the building’s roof panels, trusses, and panelized walls.

These findings also show that in considering the lifecycle embodied energy and carbon in the design of a building that two categories of materials should be used only with cautious consideration: 1) high impact materials such as concrete and aluminum and 2) materials that have no chance of reclamation such as poured in place concrete and gypsum board.

In the future, it would be useful to compare a building such as this one that is designed for deconstruction with a comparable building that is designed conventionally to generate a case study per square foot comparison of the environmental impacts of the materials themselves along with a similar comparison of end of life scenarios. Does a building that is designed for deconstruction have a higher per square foot embodied energy in the initial construction? Are there whole, reclaimable materials in a (hypothetical) conventionally constructed building?

ACKNOWLEDGEMENTS

Our sincerest thanks to architect Daniel Herbert for sharing insights and resources. Research assistance by E. Eva Peterson was supported by the Center for Housing Innovation at the University of Oregon.

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ENDNOTES

1. The SELCO Credit Union, 1450 High Street, Eugene, Oregon, completed in 1972. The building now houses a branch of the Pacific Continental Bank.

Urban Rooftops as Productive Resources

Rooftop Farming versus Conventional Green Roofs

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ABSTRACT:

Rooftops in our urban centers represent a vast potential of currently underused space. The transformation of these urban rooftops into an environmental, ecological resource through an increased implementation of green roof technology is becoming standard practice in many cities throughout the world. Due to the rapidly growing interest in urban agriculture, a new form of green roofs - rooftop farms - are emerging. This study compares the environmental, economic and social benefits of conventional and productive green roofs. The intent of this paper is to outline realizable benefits and establish methods for optimizing rooftop occupation in the urban environment.

The basis for this paper's argument is derived from data collected from a number of rooftop farming case studies located throughout North America, which highlight the differences between conventional green roofs and productive green roofs. Points of comparison fall into three groups: potential environmental, economical and social benefits.

In conclusion, this study argues that not only do productive green roofs meet the well-established environmental benefits of conventional green roofs, but they also provide extra social benefits that outweigh any additional structural requirements, operational necessities and associated costs. The implementation of productive green roofs should be considered and actively pursued wherever possible, due to their vital contribution to the advancement of urban agriculture, social and economic gains and potential job creation, which all strengthen our urban environments and communities.

CONFERENCE THEME: On Measurement

KEYWORDS: green roof, rooftop farming, urban agriculture, environmental and social benefits, building performance

INTRODUCTION

Roofs cover up to 32% of cities and built-up areas (Frazer 2005) and represent a vast potential of currently unused space in urban centers. An increased implementation of green roof technology to transform these urban rooftops into an environmental, ecological resource is becoming standard practice in many cities (Peck et al. 1999, Getter and Rowe 2006, Oberndorfer et al. 2007). Parallel to this investment in green infrastructure, urban dwellers also have developed a desire for more sustainable, health food. This rapidly growing the interest has fostered the development of urban agriculture projects cultivating organic, locally grown produce in many cities.

Through the synthesis of these two popular sustainable strategies, a new form of green roofs - the rooftop farm - is emerging. This approach is mainly applicable in dense urban areas and warehouse districts that lack open space for alternative water management infrastructure and ground based urban agriculture. It is no longer a question of whether or not green roofs should be implemented, but rather how their impact can be maximized beyond their recognized environmental values. This investigation juxtaposes scientifically measurable environmental and economic benefits as well as social benefits of conventional and productive agricultural green roofs. It outlines the significance of realizable benefits and provides an outline for optimizing rooftop design and occupation in the urban environment. It attempts to increase the recognition of productive green roofs, as a new typology of vegetated roofs that increases their applicability even further.



Figure 1: Eagle Street Farm, Greenpoint, Brooklyn, NY (<http://www.cityfarmer.info>)

With this assessment, the study contributes to the field of green roofs research, which focuses predominantly on environmental impacts, and broadens the knowledge on urban agriculture, which to date predominantly covers social, cultural and planning related aspects. In bringing these two fields of research together, this study engages in an interdisciplinary approach to analysis, which is necessary to gain a more holistic understanding of the built environment.

I. METHODOLOGY AND SOURCES

I.1. APPROACH

The basis for the argument of this study is derived from data collected from a number of North American rooftop farming case studies, which reveal the differences between conventional and productive green roofs. Data on the construction, operation and productivity of these emerging rooftop farms is set in relationship with the well-established research conducted and published on the performance and benefits of conventional green roofs. Points of comparison fall into three groups: environmental impact, life cycle costs analysis and social benefits. The findings and observation can be used as criteria for the design process of productive green roofs.

I.2. INTERDISCIPLINARY SOURCES

The analysis and understanding of green roofs and even more so of urban agriculture requires an interdisciplinary approach. Only when architectural, landscape architectural, ecological, economic, social and community aspects are collectively considered, a holistic approach to and evaluation of these emerging rooftop farm projects is possible, especially with the assessment of their potential impact to create more sustainable cities. Therefore sources from different areas of research were integrated in this study. The seminal articles on green roofs as urban ecosystems by Erica Oberndorfer et al (2007) and Kristin Getter and Bradley Rowe (2006) provide a detailed environmental analysis and performance evaluation of green roofs. Jeroen Mentens et al. (2005) offer comprehensive information on the impact of green roofs on urban water management. The research conducted by Nyuk Hien Wong et al. (2003) as well as Ulrich Porsche and Manfred Köhler (2003) present a basis for life cycle and cost analysis. The information on rooftop farms is derived from articles and data often published by the owners, farmers, and suppliers on the Internet, largely due to their very recent construction.



Figure 2: Brooklyn Grange, Long Island City, Queens, NY (http://brooklyngrange.files.wordpress.com/2010/08/bgfarm_notitle.jpg)

2. ROOFTOP FARMS

2.1. RECENT TRENDS

Over the past five years, numerous urban roof top farms started their operation in Toronto, New York, Vancouver, Chicago, Portland, Seattle and other North American cities (Chart 1). Their emergence over a short period of time reflects and responds to the growing interest of urban dwellers in locally produced organic food and more sustainable urban environments as well as the slow, but persistent acceptance of green roofs in North America.

2.2. EDUCATIONAL ROOFTOP FARMS

Already documented since 1999, the report on Urban Agriculture and Food Security Initiatives in Canada states that the use of rooftop gardens as farming spaces has considerable potential to produce substantial amounts of food and contribute to a sustainable urban environment (Fairholm 1999). Early community based pilot projects of food producing urban roof gardens can be found in Toronto and Vancouver. The Trent University Experimental Rooftop is one of the first rooftop farm of substantial size. Conceived and constructed as a research and organic vegetable garden more than 10 years ago, the farm is still run by a student group today and produces food for the local campus restaurant. Similar to this early case study, many recent rooftop farms have been established by educational institutions and youth centers. Their primary goals are to provide students with the educational experience of gardening and healthy food in dense neighborhoods where ground base gardens are not available.

2.3. COMMERCIAL ROOFTOP FARMS

Driven by the marketability of locally grown produce and fresh herbs on their menu as well as the convenience of having those directly available, many restaurants install kitchen garden on their roofs in dense urban neighborhoods. These rooftop gardens tend to be container gardens, which allows an easier installation on existing roofs and small, but deeper growing beds, which provide adequate space for the needs of one commercial user. The most recent developments are large commercial

enterprises, such as Brooklyn Grange, which transform vacant, unused rooftops into large urban farms. Their operation began in 2008 with a small prototype, the Eagle Street Farm (Figure 1). After its first successful year, a nearly seven times larger, one-acre farm was installed on a rooftop in Long Island City and started operation in 2010 (Figure 2).

2.4. HYDROPONIC ROOFTOP FARMS

The rapidly increasing interest in and the growing market for locally grown, organic produce also fosters the development of hydroponic farms on urban rooftops. These farms grow vegetables with nutrient-rich, liquid growing medium in green houses. After testing the technology in small-scale applications, as for example the Science Barge on Hudson River, large scale projects are now either designed, such as Gotham Greens in Brooklyn, NY or under construction, like the Lufa Farm in Montreal, QC. This study looks at rooftop farms or productive green roofs, which fall technically in the category of intensive green roofs and follow their construction principles. Therefore these hydroponic rooftop farms will not be part of this study. The analysis and comparison between green roof and hydroponic farms offers a wide field for further research.

		year completed	retrofitted	new construction	container/ raised	surface beds	hydroponic	environmental	economic benefits	social benefits	size: total (cultivated) sq ft
EDUCATIONAL schools											
Trent University Experimental Rooftop Garden <i>www.cityfarmer.org/</i>	Toronto, ON	2000	•		•		•	•	•		30,000 (20,000)
Trillium Charter School <i>www.trilliumcharterschool.org</i>	Portland, OR	2010	•	•	•		•	•	•		
St. Simon Stock School <i>www.greenroofs.com/</i>	Bronx, NY	2005	•		•		•	•	•		3,500 (1000)
youth centers											
Gary Comer Youth Center <i>www.gcyhome.org/</i>	Chicago, IL	2006		•	•		•	•	•		8,400
YWCA Rooftop Community Food Garden <i>www.ywcavan.org</i>	Vancouver, BC	2006	•		•		•	•	•		2,100 (1,000)
COMMERCIAL restaurant kitchen garden											
Bastille <i>www.bastilleseattle.com/</i>	Seattle, WA	2009	•		•		•	•			4,500 (800)
Rocket Building <i>www.burnsiderocket.com/</i>	Portland, OR	2007		•	•		•	•			2,100 (800)
Organic Rooftop Farm Uncommon Ground Restaurant <i>www.uncommonground.com</i>	Chicago, IL	2008	•		•		•	•			2,500 (650)
Rooftop Kitchen Garden Fairmont Waterfront Hotel <i>www.cityfarmer.info</i>	Vancouver, BC	2006		•	•		•	•			2,100
commercial farms											
Eagle Street Rooftop Farm <i>www.RooftopFarms.org</i>	Brooklyn, NY	2008	•		•		•	•	•		6,000 (~5,500)
Brooklyn Grange <i>brooklyngrangefarm.com</i>	Queens, NY	2010	•		•		•	•	•		40,000 (37,000)
hydroponic farms											
Science Barge (prototype) BrightFarms/ NY Sun Works <i>brightfarmsystems.com</i>	New York, NY	2007		•			•	•	•		1,300
Gotham Greens (designed) <i>gothamgreens.com</i>	Brooklyn, NY	2011	•				•	•			16,000
Lufa Farm (under construction) <i>www.lufa.com/</i>	Montreal, QC	2011	•				•	•			31,000

Table 1: Urban rooftop farms in North America. Source: (Author 2011)

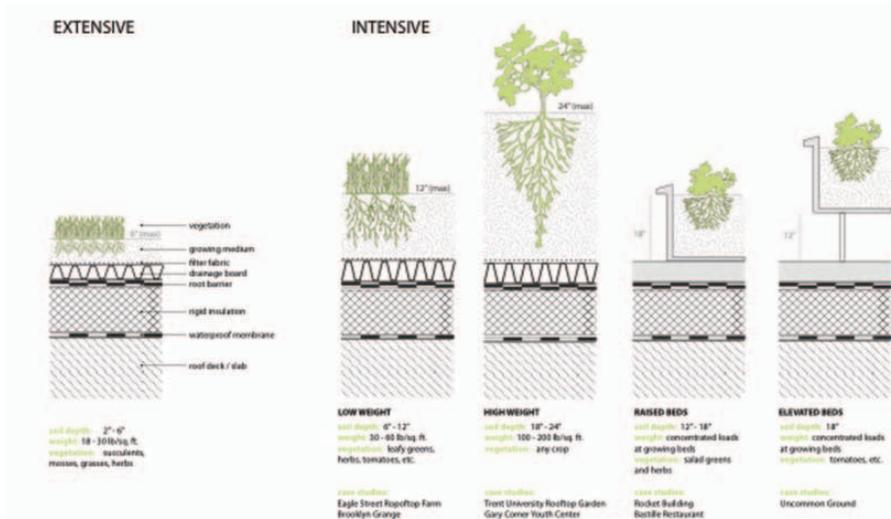


Figure 3: Green roof and rooftop farm construction types. Source: (Author 2011)

3. CONSTRUCTION AND DESIGN

3.1. GREEN ROOF TYPES

Green roofs basically consist of a vegetation layer, a substrate (or growing medium) layer, in which water is retained and the vegetation is anchored, and a drainage layer (or reservoir board) to evacuate or store excess water (Mentens et al. 2005). A waterproofing membrane and root barrier separates these water-carrying layers from the actual roof structure, which consists of an insulation layer and the roof slab or structural support. The depth of the substrate determines the roof's environmental properties, the plant selection that can be grown and the weight and therefore the structural requirements of the roof. Two main types of green roofs are distinguished based on the depth of their substrate layer: extensive with substrate layers with a depth less than 6" (15 cm) and intensive with substrate layers thicker than 6" (15 cm) (Mentens et al. 2005). In order to compare conventional and productive green roofs, the construction type of rooftop farms must be carefully examined. Most rooftop farms investigated in this study have continuous substrate layer and surface growing beds. They fall into the group of intensive green roofs and their building performance and benefits can be compared (Figure 3). Whereas, rooftop farms with raised beds cover only a certain percentage of the roof area with growing area. Elevated beds are even lifted off the roof surface. Both construction systems realize only a small percentage of environmental benefits and do not improve the building performance and can therefore not be directly compared with conventional green roofs.

3.2. SUBSTRATE COMPOSITION

The most critical component for the success of a green roof or rooftop farm is its substrate, which is characterized by its composition, depth and weight. For long-term sustainability, substrate is commonly composed out of 80% (or more) mineral, often light-weight aggregate and 20% (or less) organic material (Luckett 2009). The porous mineral components provide weight reduction, store water and break down very slowly to maintain the volume of the growing medium. The organic components break down quickly and become available as nutrients for the plants. Especially with the intensive use of the growing medium through the rooftop farms, the organic material has to be replaced and recharge with fertilizing compost or organic matter. Therefore organic rooftop farms include often a compost cycle into their operation.

	Bastille Restaurant's Rooftop Garden	Eagle Street Rooftop Farm	Brooklyn Grange	Gary Comer Youth Center	Trent University Environmental and Resource Sciences Vegetable Garden
location	Ballard Seattle, WA	Green Point Brooklyn, NY	Long Island City, Queens, NY	Grand Crossing Chicago, IL	Toronto, ON Canada
year completed	2009	2008	2010	2006	2000
roof area/ cultivated area percentage growing area	2,500 sq. ft./ 800 sq. ft. 32%	6,000 sq. ft./ 5,400 sq. ft. 90%	40,000 sq. ft./ 37,000 sq. ft. 93%	8,160 sq. ft./ 5,800 sq. ft. 71%	30,000 sq. ft. 20,000 sq. ft. 66%
containment	containers and raised beds	surface beds	surface beds	surface beds	surface beds
substrate depth	containers: 18" raised beds: 12" NA	6"-7"	7.5"	24"	18"
substrate weight	NA	ca. 60 lb/ cubic ft. 33 lb/ sq. ft.	"roofite intensive" 44-53 lb/ cubic ft. 30 lb/ sq. ft.	NA	saturated soil 100lb/ cubic ft. 150 lb/ sq. ft.
retrofit or new construction	retrofit	retrofit	retrofit	included in new construction	included in original construction
construction system building	1-story warehouse, needed structural retrofit	3-story prewar warehouse	7-story warehouse, supports 130 lb/ sq. ft.	steel structure, built 2006	NA, built 2000
construction cost	NA	\$10/ sq. ft. material cost	\$ 5/ sq. ft. material cost	NA, \$ 30 Million project in total	NA
annual precipitation	37.2"	47.3"	47.3"	35.8"	31.2"
irrigation system	drip irrigation	drip irrigation	drip irrigation	irrigation system	irrigation system
hardiness zone	7-8	6-8	6-8	5-6	5-6
growing season	Mar 10 - Nov 17, 251 days all year round, sun shading + heated growing beds	April 1 - Nov. 15, 227 days	April 1 - Nov. 15, 227 days 9 months with cover crops during the winter months	April 20 - Oct. 24, 187 days sunken courtyard extends season	May 9 - Oct. 6, 149 days
yield	NA	NA	16,000 lb, 0.4 lb/ sq. ft. 5.5 tons/ acre	1,000 lb 0.12 lb/ sq. ft.	NA
crop distribution	downstairs restaurant	CSA, local farmers market, local restaurants	CSA, local farmers market, local restaurants	students, center's cafeteria, local restaurants	local cafeteria, restaurant on campus
number of employees	1 part-time + kitchen staff	1 employee + many volunteers	5 partners (part time) + many volunteers	1 full-time, 2 part-time employees (students)	run by students, 1 full time gardener over the summer
social and educational programs web site	rooftop farm tours http://www.digginfood.com/2009/09/bastille-restaurants-rooftop-garden/	apprenticeship, education programs http://rooftopfarms.org/	apprenticeship, education programs http://brooklyngrangefarm.com/	multilayered educational programs http://www.gycyhome.org/	http://www.cityfarmer.org/

Table 2: Rooftop farming case studies. Source: (Author 2011)

CONSTRUCTABILITY AND SUBSTRATE WEIGHT

The constructability of vegetated roofs depends largely on their increased weight, which is predominantly defined by the weight and depth of the substrate. Some of the educational rooftop farms investigated here were integrated during the design phase of the buildings and had generous budgets. This allowed the realization of an optimal depth of growing medium and structural support. The Trent University rooftop garden accommodates for example the weight of saturated soil, which equals approximately 100 lb per cubic foot. Therefore the roof carries a dead load of 180lb per square foot. The constraining factor for retrofitting existing rooftops is the load-bearing capacity of the roof, therefore lighter

substrate mixes have to be developed for these applications. The retrofitted rooftop farms in New York City have been successfully constructed on prewar warehouse type buildings. Their roofs usually support as much load as their individual ceilings. The roof that carries the Brooklyn Grange for example supports roughly 130 lb per square foot. All of the farm's materials combined weigh only between 30 - 40 lb per square foot, even when the soil is fully saturated with water - much less than the structural limit of the roof (Table 2).

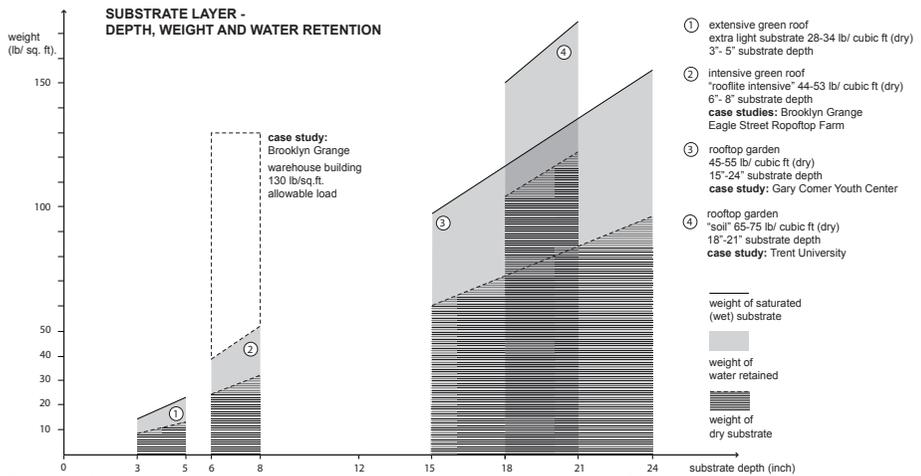


Figure 4: Green roof and rooftop farm construction types. Source: (Author 2011)

4. ENVIRONMENTAL BENEFITS

4.1. STORM-WATER MANAGEMENT

In the United States, 60-95% of the built-up area is covered by impervious surfaces (Frazer 2005). These hard, nonporous surfaces cannot absorb precipitation and therefore contribute to heavy runoff, which constitutes about 75% of the rainfall in cities. Dense urban areas often lack space to build low-impact storm-water management facilities; therefore green roofs are ideal storm-water management tools. They utilize an unused spatial resource and keep the water at its source. The same is true for urban roof farms (with surface growing beds). They offer the same water management benefits and additionally the opportunity to cultivate produce in places where no open space or vacant lots for ground based growing are available. Green roofs and rooftop farms retain water during rainfall events, delay its runoff, and increase the volume of water returned to the atmosphere directly through evapotranspiration. The depth of substrate has the greatest effect on the runoff rate (Mentens et al. 2005). In general, the deeper the substrate layer, the lower the run-off rate.

4.2. WATER REQUIREMENTS

One of the main differences between conventional, extensive green roofs, which are intended to mitigate runoff and intensive, productive green roofs is their water need. Extensive roofs are adapted to the local climate and water naturally available through precipitation, also during dry periods in the summer. Rooftop farms, however, must have access to enough water during the growing season for their crops to thrive. Roof top farms with thick substrate layers (6"-24") can retain up to 85% of rainwater (Mentens et al. 2005). Eggshell or dimpled reservoir mats integrated in the drainage layer can provide additional water retention and storage (Luckett 2009). Nevertheless, depending on the local climate and annual precipitation pattern, additional irrigation might be necessary. The water needs for local agriculture are a guide, but since rooftops receive more sun exposure and wind, which dry out the soil, the water needs on a productive roof will be higher than for ground based farming in the same location. Therefore the dimensioning and integration of an effective irrigation system is important. Localized drip irrigation, which brings the water directly to the roots, is most effective since the water cannot be blown off the roof by the wind. Rain water availability, water retention potential of the substrate, farming methods as well as the water needs of the crop species grown need to be balanced. In regions with seasonal fluctuation of precipitation, especially in climates with winter rains and summer droughts, the potential of rainwater harvesting and storage should be taken into consideration. The use of harvested rainwater reduces the demand for potable, communal water for irrigation and the environmental strain on fresh water resources during the summer months.

4.3. SUMMER COOLING

Besides the ability to retain rainwater, green roofs add insulation and thermal mass, which increases with the depth and composition of the substrate, to the roof. The improved insulation value and mass reduce the heat transfer through the roof. Simultaneously, the vegetation of the green roof promotes physical shading and an increased evapotranspiration rate. (Oberndorfer et al. 2007) This improved performance is reflected in the breakdown of the total solar radiation absorbed by the planted roof: 27% is reflected, 60% is absorbed by the plants and the soil and only 13% is transmitted into the soil (Eumorfopoulou 1998). The solar energy gain on a green roof can be reduced by up to 87% compared with non-shaded buildings surface (Wong et al. 2003). The reduced heat transfer into the building results in improved building performance and energy savings. This is especially evident during warm summer month and lowers the energy demands for the building cooling system (Oberndorfer et al. 2007).

Rooftop farms with continuous surface beds and deep

substrate layers offer additional insulation and thermal mass to improve the building performance and buffer temperature swings. Container rooftop gardens, with a low percentage of growing area coverage and unequal distribution of substrate across the roof area or rooftop gardens with elevated beds, do not provide these improvements of building performance.

4.4. URBAN HEAT ISLAND EFFECT

On an urban scale, the summer cooling of green roofs and rooftop farms contributes also to the mitigation of the urban heat island effect. Metropolitan areas, through their lack vegetation and agglomeration of dark impervious surfaces, are significantly warmer than their surrounding rural areas, especially at night. The air temperature above vegetated roofs can be up to 30°C lower compared to conventional roofs, resulting in up to 15% of annual energy consumption savings (Getter and Rowe 2006).

4.5. EVAPOTRANSPIRATION

Experiments on green roofs suggest that most of the summer cooling benefits from green roofs are attributed to evapotranspiration, which is the sum of evaporation from the soil and plant transpiration to the atmosphere (Oberndorfer et al. 2007). When water is readily available, the evapotranspiration rates are much greater on vegetated roofs than on roofs with growing medium alone, especially during the summer months (Oberndorfer et al. 2007). Transpiration from living plants is responsible for a substantial portion of the cooling benefits of green roofs. Through the selection of plant species with high leaf conductivity or surface area, this proportion could be even further increased (Oberndorfer et al. 2007). Many crops cultivated on rooftop farms have large leaves and high water conductivity. Therefore the summer cooling effect offered by productive green roofs with ample vegetation is very large. In this respect, the need for additional irrigation water is offset by the cooling effect through the increased plant transpiration. Rooftop farms can outperform the cooling benefit of conventional green roofs that strive to adapt planting to water availability.

4.6. CARBON SEQUESTRATION AND NOISE REDUCTION

Studies show that extensive green roofs with a low biomass have only a very small potential to offset carbon emissions in cities. Intensive green roofs and intensively planted rooftop farms, however, could make a significant contribution to the air quality in cities as urban carbon sinks (Oberndorfer et al. 2007). Green roofs also reduce also sound pollution. Substrate and vegetation absorb sound waves outside buildings and prevent their inward transmission (Dunnnett and Kingsbury 2004).

ENVIRONMENTAL BENEFITS

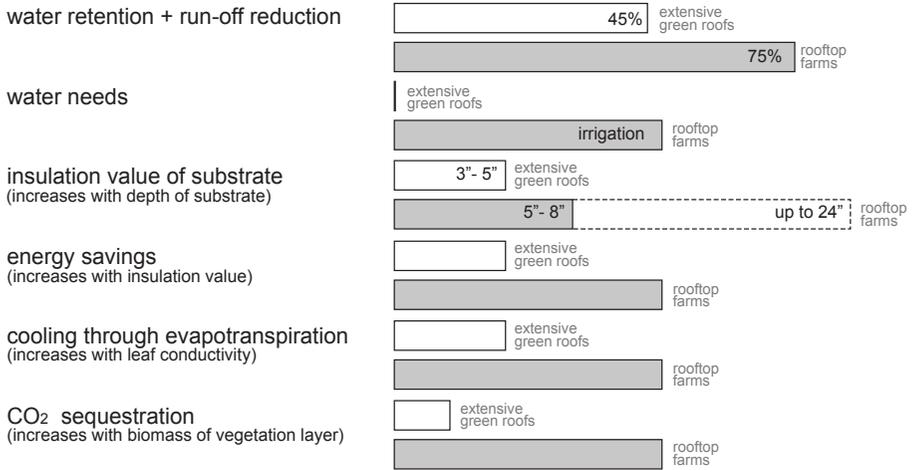


Figure 5: Environmental benefits of extensive green roofs and rooftop farms. Source: (Author 2011)

5. ECONOMIC BENEFITS

5.1. LIFE CYCLE COST ANALYSIS

So far developer and building owners have often shied away from green roofs based on their higher initial costs and the slower return of investment. The life cycle cost analysis of green roofs could be improved by evaluate their various areas of value more holistically and by considering benefits that are difficult to quantify. These assessments have to include the importance of human well-being and the longer-term goals of environmental sustainability. Productive green roofs offer in addition the value of their yields, jobs and educational programs.

5.2. EXTENDED LONGEVITY

On conventional urban roof surfaces high temperatures are often reached through sun exposure, which create high levels of stress on the roofing systems and materials. Dark waterproofing membranes deteriorate rapidly in ultraviolet light (Oberndorfer et al. 2007). The vegetation cover and substrate layer of green roofs moderate the temperature extremes and physically protect the waterproofing membrane from ultraviolet (UV) radiation and mechanical forces (Wong et al. 2003). A correctly installed vegetated roof has an increased lifespan of 3-4 times that of a conventional roof (Wong et al. 2003, Lockett 2009). Some green roofs in Berlin even demonstrate a lifespan of more than 90 years without needing major repairs (Porsche and Köhler 2003).

5.3. INITIAL COSTS

The price of the installation of green roofs depends on the location, availability of green roof construction systems, the substrate depth, its composition and the type of vegetation. In comparison to low-priced, conventional roofs (with a lifespan of only 15 years), green roofs can cost up to three times more (Porsche and Köhler 2003). Recently documented prices in the United States range from \$7.50 per sq. ft. for conventional roofs to \$25 per sq. ft. for the installation for green roofs. Over the 60-year lifespan of the green roof, the conventional roof will need three major repairs or replacements. After a total roof investment of \$ 51 per sq. ft. (including the inflation rate) the conventional roof will be twice as expensive than the green roof. (Lockett 2009). A short-lived, low-first-cost product is often not the cost-effective alternative. (Wong et al. 2003) A higher first cost for

green roofs will be justified many times over for a durable product with minimal maintenance and environmental benefits, especially since this calculation does not take the larger use resource and environmental strains in account for renewing a roof three times. The construction and installation cost of rooftop farms vary widely depending on the structural capacity of the building, substrate depth and farming method. Some of the institutional, educational projects are very well funded, whereas the commercial projects are start-ups with low budgets. The cost for the retrofit for the Eagle Street Farm with a substrate depth of 6" was only \$10 per sq. ft., which were funded by donations and installed with the help of volunteer work (Figure 6).

ECONOMICAL BENEFITS

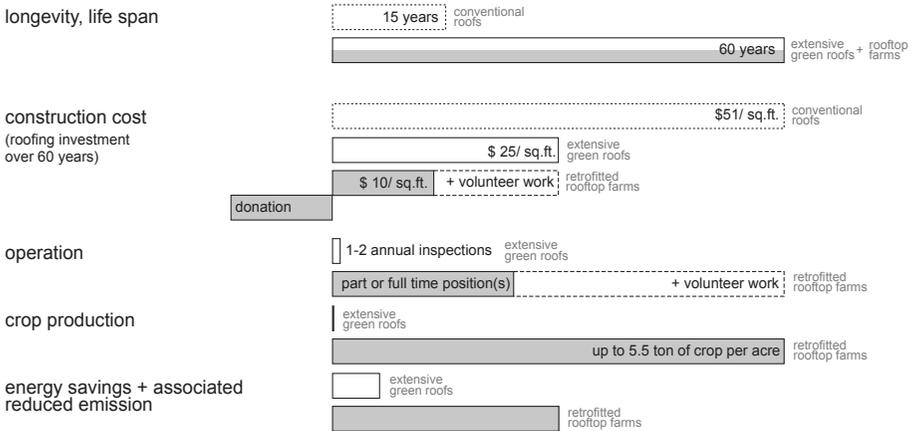


Figure 6: Economical benefits of extensive green roofs and rooftop farms. Source: (Author 2011)

5.4. OPERATIONAL REQUIREMENTS AND PRODUCTION

The vegetation of any green roof requires maintenance. Extensive roofs need low maintenance; only 1-2 annual inspections to remove weeds and tree seedlings and check the roof waterproofing and drainages systems. Intensive green roofs require more maintenance depending on the selection of plants. The maintenance of rooftop farms is part of the operation. Depending on the type of farm, this can be either part of the curriculum of the educational institution or part of the business plan of a commercial enterprise, which results in job creation. Most rooftop farms investigated have one full- or part-time employee, but rely mostly on volunteers supporting the farms throughout the growing season.

5.5. ECONOMIC VALUE OF ENVIRONMENTAL BENEFITS

The environmental benefits of green roofs also translate in economic benefits. Although difficult to include in a per-project cost analysis, the reduction of storm-water runoff through green roofs has an enormous value for cities and communities. It releases city finances from new investments and maintenance cost of their urban storm-water treatment facilities. If 6% of the roof area in Toronto would be covered with green roofs, the impact on storm-water retention would equal the construction of a \$ 60million (CDN) retention tunnel (Peck et al. 1999).

Many communities across the US have adopted storm-water treatment fees to fund the treatment of storm- water runoff. Most of these fees are assessed across the entire population based on the treatment cost and not based on the “polluter pays principle”. Currently, storm-water fees are unrealistically low. The adjustment of these to reflect the actual cost of storm-water infrastructure and treatment and the introduction of credit for green roofs construction would help to create an additional financial incentive for green roof implementation.

5.6. ENERGY SAVINGS

Green roofs improve building performance, especially during the summer (see 4.3.). Research studies have shown that green roofs can reduce the indoor temperatures by at least 3°C to 4°C when outdoor temperatures are between 25°C - 30°C (Peck et al. 1999). The decrease of the indoor temperature by 0.5°C may reduce electricity demand for air conditioning by up to 8% (Dunnett and Kingsbury 2004). For individual building it has been shown, that the electricity use for cooling on a summer day can be reduced by 64%.

Buildings consume 36% of all energy used and contribute to 65% of all electricity consumption; therefore the implementation of green roofs on a large scale could generate significant energy savings (Kula 2005). After the installation of a green roof on the Chicago city hall, the energy savings could be \$4000 annually for heating and cooling combined. If all buildings in Chicago had green roofs, the savings could be \$ 100 Million annually (Laberge 2003). In addition to the immediate energy savings, the reduced emission through decreased energy consumption is also considered as an environmental benefit.

6. SOCIAL BENEFITS

6.1 RECOGNITION OF SOCIAL BENEFITS

Green roof research focuses primarily on environmental performance; though social and community benefits as well as improvements of the urban human habitat are acknowledged as by-products. Living roofs provide aesthetic and psychological benefits for people in urban areas. Even green roofs that are only accessible as visual relief provide relaxation, improve human health and reduce patients' recovery times in healthcare environments through the simple visual contact with vegetation (Copper-Marcus and Barnes 1999). Likewise, the visual and physical access of employees to green roofs at their workplace increases employee satisfaction, productivity and reduces stress (Luckett 2009).

In this respect, the benefits of urban rooftop farms start where conventional green roofs end. One of their primary goals is to provide social benefits. For educational rooftop farms this agenda is obvious, but also commercially run rooftop farms investigated in this study build also on strong community ties, educational programs, and volunteer projects.

6.2 EDUCATION AND ACCESS TO FRESH FOOD

Educational rooftop farms, such as the Gary Comer Youth Center in Chicago, have multilayered educational programs. Children learn about the seed-to-harvest cycle, environmental concerns,

SOCIAL BENEFITS

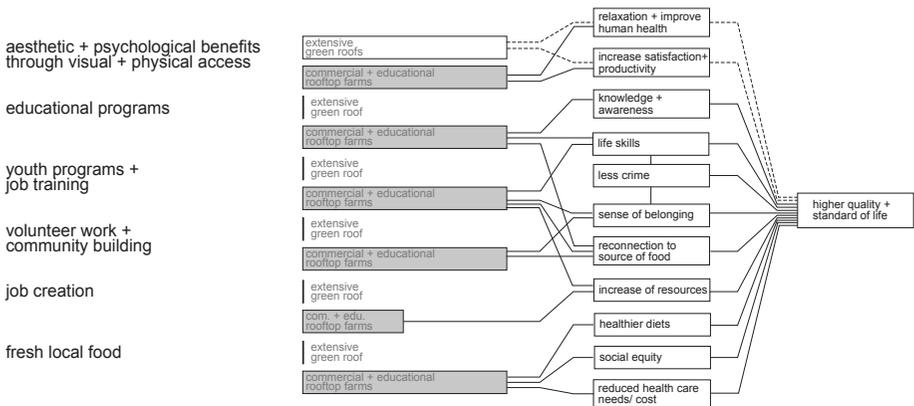


Figure 7: Social benefits of extensive green roofs and rooftop farms. Source: (Author 2011)



Figure 8: Gary Comer Youth Center (http://www.thelocalbeet.com/wp-content/uploads/2009/07/Kessler_GaryComer-1.jpg)

botany, and the processes of nurturing growth in a garden. They also learn about nutrition and healthier diets, which could eventually have a tremendous impact on the public health of their community. This education on healthier diets is immediately put in action with the increased access to fresh food. The vegetables grown on the rooftop are used by cooking classes, local cafeterias or distribute to the students and their families. Similar educational programs for children and teenagers are also offered by some of the commercially run rooftop farms. Furthermore, their greatest contribution to the community is providing access to locally grown fresh produce, especially in urban areas that are challenged with otherwise low availability of healthy food. The produce is either sold directly at the farm, on farmers markets or through community supported agriculture (CSA) organizations.

6.3 COMMUNITY BUILDING

The community around rooftop farms flourishes not only with new access to fresh food, but more importantly with the development of new networks and community ties. Most rooftop farms rely on volunteer work and therefore offer community members the chance to get in direct contact with the source of their food. People describe the experience of being involved in the process of producing their own food as very fulfilling. This sense of accomplishment has especially a positive impact on youth growing up under challenging circumstances. Therefore many rooftop farms offer youth programs and job training. Commercially run rooftop farms also contribute to the larger community by creating an economic stimulus, particularly in neighborhoods that otherwise suffer from low business activity. New farm enterprises might directly or indirectly create new employment opportunities and attract other businesses to the location.

CONCLUSION

The comparison shows that not only do productive green roofs meet the well-established environmental benefits of conventional green roofs, such as the contribution to water management, summer cooling and an improved building performance (as described by Getter and Rowe 2006 and Oberndorfer et al. 2007), but they also provide additional social and economical benefits. These benefits include educational programs, community building and health benefits as well as resource conservation, production of local produce and job creation. The challenge for the allied design and planning professions is to learn from the emerging successful case studies. The retrofit of existing buildings covering a greater area of dense urban centers would have a strong, positive impact on the urban environment.

In conclusion, this investigation shows that productive green roofs should be implemented wherever possible, due to their vital contribution to the advancement of urban agriculture and the associated environmental, social and economic gains, all of which strengthen the environment and urban communities.

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From a Consumer Product to a Complex Building: A Quantitative Approach to Sustainability Using Life Cycle Assessment (LCA)

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ABSTRACT:

As sustainability becomes a central figure in the design process in both architectural education and practice, conducting such environmental research is gaining high momentum in architectural education and practice worldwide. Although many architects claim their buildings to be sustainable, unless a comprehensive Life Cycle Assessment (LCA) study is conducted, it is difficult to *calculate* and *evaluate* the total burden that a particular building has on its surrounding and global environment. This paper demonstrates how LCA could be applied from a single bldg material or consumer product to a complex system such as an entire building throughout its life cycle. It highlights the difficulties in modeling the whole building over a long service life (60 years) and its implications on the construction process. Studying the whole life cycle of a building also shows to what extent each life cycle phase contributes to the total burdens, where some environmental strategies could be applied to reduce the total burden. The paper also examines the significance of these impacts that occur during the life cycle through a case study of an office building in Michigan. It aims also to provide a comprehensive assessment to which building component (structure, walls, floors, etc.) contribute the most to the total impacts to inform architects' design decisions of buildings components that could reduce the total environmental burdens.

CONFERENCE THEME: Sustainability Measurements

KEYWORDS: Environmental research, Sustainability, Quantitative Methodology, Life Cycle Assessment, Environmental burden.

I. INTRODUCTION

In recent years, building-related environmental issues have become increasingly important. The construction and building sector has been found to be responsible for a large part of the environmental impacts on human activities. For example, in the United States, the construction and building sector has been estimated to be responsible for roughly 40% of the overall environmental burden (U.S.DOE 2002). Building-related environmental issues are also important for companies. There are already more than 40,000 companies in the world that have been certified to the ISO 14001 Environmental Management System EMS (ISO 2002b). Many large companies such as IBM, General Motors, and Ford are now requiring or, at least, encouraging EMS registration from their suppliers (ISO 2002a). Management of building-related environmental issues requires tools and knowledge that enable the control of environmental aspects, thus minimize the environmental impacts (Roberts and Robinson 1998). An environmental aspect in this context is now an element of an organization's activity, product, or service that interacts with the environment (ISO 1996).

I.1 BACKGROUND: LIFE CYCLE PERSPECTIVE

LCA represents a quantitative tool for calculating the environmental burdens (impacts) of products at all stages in their life cycle from cradle to grave. Throughout the life cycle of a building, various natural resources are consumed, including energy resources, water, land, and several pollutants are released back to the global/regional environment. These environmental burdens result in global warming, acidification, air pollution, etc., which impose damage on human health, primarily natural

resources and biodiversity. The building sector, constitutes 30-40% of the society's total energy demand and approximately 44% of the total material use as well as roughly 1/3 of the total CO₂ emission, has been identified as one of the main factors of greenhouse gas emissions. There is no doubt that reducing the environmental burden of the construction industry is crucial to a sustainable world.

Most research on the environmental impacts of buildings examine the issues at a relatively broad level though extensive descriptions. For example, Finnveden and Palm (2002) stated that the use phase accounts for the majority of the environmental impacts of buildings. Klunder (2001) gave a description of environmental issues of dwellings, noting that assessments should focus primarily on components that involve large quantities of materials (e.g., foundation, floors, and walls), but there are also dangerous materials that should be avoided regardless of quantity (e.g., lead). Energy consumption in space heating, hot water, lighting, and ventilation should be studied along with the energy carrier (electricity or gas). Some of the building-related environmental studies present detailed quantitative data about the life cycle of a building (Scheuer et al., 2003). However, most studies only utilize one or two indicators of environmental impacts. Treloar et al. (2001) have used a hybrid input-output model to estimate the primary energy consumption of building materials to study the relative importance of different life-cycle phases. Seo and Hwang (2001) evaluated the life-cycle primary energy usage and CO₂ emissions of residential buildings in Korea. The results are presented by building materials and life-cycle phases, including materials manufacturing, operational energy, and demolition.

Other quantitative studies have used a wider set of environmental impact indicators in their analyses, but have only included certain life-cycle elements. Junnila and Saari (1998) have used life-cycle inventory analysis to estimate the primary energy consumption and environmental emissions of CO₂, CO, NO_x, SO₂, volatile organic compounds (VOCs), and particulates from a residential building. The life-cycle phases studied included manufacturing of structural materials, construction, operational energy, maintenance, and demolition. Trusty and Meil (2000) have assessed the environmental impacts of an office building, including the structural and envelope elements, which were compared against the annual operational energy. Junnila and Horvath (2003) took the same path to quantify the most significant impact of a high-end office in Europe.

Despite the studies about the environmental impacts of buildings, it is still very difficult to find comprehensive information about the life-cycle impact of office buildings. Most of the previous studies have concentrated on either a limited set of life-cycle phases, or only one or two environmental impact indicators. Building assembly systems (structural, envelope, floors, and roofs) are rarely included, despite the fact that in practice most of the buildings are designed by such building systems or design disciplines. Thus, such information and data indicating the significant aspects by building systems would be of great use in design management.

2. APPROACH, METHOD, AND ASSUMPTIONS

A life-cycle assessment (LCA) framework is selected to analyze the environmental impacts of a new office building in Southeast Michigan. Sixty years of use was assumed to be the basic life cycle. LCA is the most appropriate framework for the identification, quantification, and evaluation of the inputs, outputs, and the potential environmental impacts of a product, process, or service throughout its life cycle, from cradle to grave i.e., from raw material acquisition through production and use to disposal [as defined in ISO 14040, 1997]. The LCA had three main phases; inventory analysis for quantifying emissions and wastes, impact assessment for evaluating the potential environmental impacts of the inventory of emissions and wastes, and interpretation for defining the most significant aspects.

LCA is defined as a systematic, holistic, objective process to evaluate the environmental burdens associated with a product or process. The process identifies and quantifies energy and material usage and environmental releases of the studied system, and evaluates the corresponding impacts on the environment. Although LCA is widely used to assess environmental impacts of products and processes, it has its limitations, which are important to recognize while interpreting the results of an LCA study. For example, ISO 14040 (ISO 1997) has listed the following limitations. There are subjective choices (e.g., system boundaries, selection of data sources, and impact categories), the

models used in inventory and impact assessment are limited (e.g., linear instead of nonlinear), the local conditions may not be adequately represented by regional or global conditions, the accuracy of the study may be limited by the accessibility or availability of relevant data, and the lack of spatial and temporal dimensions introduces uncertainty in impact assessment. Identification and quantification of material and energy flows (inputs and outputs) of the case study office building were conducted during the design and construction of the building in 2008. The material and energy flows of the building's life cycle were primarily derived from the floor plans and specifications of the building.

Some emissions data related to different energy and material flows were collected mainly from the actual manufacturers in Michigan. The quality of the data used in the life-cycle inventory was evaluated with the help of a six-dimensional estimation framework recommended by the Nordic guidelines on LCA (Lindfors et al. 1995). The quality target for the LCA was set to be at the level of "good," which means reliability of most recent documented data from drawings, specs sheets, and contractor rep on-site. In life-cycle impact assessment, the magnitude and significance of the energy and material flows (inputs and outputs) were evaluated. The impact categories included were those identified by EPA (2006) as 'Commonly Used Life Cycle Impact Categories'. Among the 10 listed categories, the impact categories in this paper included:

- Fossil Fuel Use FFU,
- Resources Use RU,
- Global Warming Potential GWP (Climate Change),
- Ozone Depletion Potential ODP,
- Acidification Potential AP,
- Eutrophication Potential EP, and
- Photochemical Ozone Creation Potential POCP or Summer Smog

The chosen impact categories are also on the short list of environmental themes that most environmental experts agree to be of high importance in all regions of the world and for all corporate functions (Schmidt and Sullivan 2002). Furthermore, the used impact categories are consistent with the air and water emissions that the World Bank (1998) has recommended to be targeted in environmental assessments of industrial enterprises. The classification, or assigning of inventory data to impact categories, and the characterization, or modeling of inventory data within the impact categories (ISO 1997), were performed using the ATHENA 4.1 life-cycle calculation program (2010) which is used to model the building. The significance of different life-cycle aspects is evaluated by comparing the environmental impacts of different building elements in every impact category so that the significant environmental impact could be ranked in order of importance. In the life-cycle interpretation section, the results are also examined from the building assembly (foundation, walls, floors, etc.) so that the environmental impact of each system's life cycle can be quantified.

2.1 CASE STUDY BUILDING DESCRIPTION

The building chosen for the study is a new office building in Michigan. The targeted use of the building is mainly medical offices. The building has 29,000 sq ft (2690 m²) of gross floor area, and a volume of 423,000 cu ft (11,978 m³) The building consists of 3 floors plus a partial basement. The structural frame is steel with cast-in-place concrete foundations. The annual energy consumption is calculated using eQuest 3.64 (2010), a DOE interface for energy simulation. The estimated natural gas consumption (mainly for water heating) of the building is 1585 Btu/sq ft/year (eq. 0.46 kWh/sq ft/year). The estimated electricity consumption is 14.2 kWh/sq ft/year, which is close to the average in such cold weather in Michigan.

In the study, the life cycle of the building was divided into 5 main phases; building materials manufacturing, construction processes, operation phase, maintenance, and demolition. Transportation of materials was included in each life-cycle phase. The building materials phase included all of the transportation to the wholesaler warehouse. The construction phase included the transportation from the warehouse to the site. The summary of energy and material flows used in the LCA is presented in Table 1.

2.2 BUILDING ELEMENTS AND MATERIALS

The following building element categories were included in the study: foundation, structural frame (beams & columns), floors, external walls (envelope), roofs, and some internal elements e.g., doors, partition walls, suspended ceilings, and 2 stairs. The amount of each material used in the building was derived from the bill of quantities, architectural and engineering drawings, and the architect's specifications. Around 30 different building materials were identified and modeled.

2.3 BUILDING CONSTRUCTION

The construction phase of the building included all materials and energy used in on-site activities. Data were modeled for the use of electricity, construction equipment, transportation of building materials to the site (average 100 mi). Some of the data were collected from the contractor, and were further confirmed by interview with his representative on-site.

2.4 BUILDING OPERATION AND USE

The use of the building was divided into mainly heating service (by natural gas) and electrical consumption. For the purpose of energy simulation, the building was estimated to be used 55 hr/week for 60 years. Energy calculations were performed using eQuest, a DOE 2 energy simulation program for electricity use and HVAC heating and cooling loads. All building parameters (dimensions, orientation, walls, windows, etc) were modeled.

2.5 MAINTENANCE

The maintenance phase included all of the life-cycle elements needed during the 60 years of maintenance; use of building materials, construction activities, and waste management of discarded building materials. An estimated 75% of building materials was assumed to go to landfill, and 25% was assumed recovered for other purposes such as recycling.

2.6 DEMOLITION

The demolition phase included demolition activities on-site, transportation of discarded building materials (75% of the total) to a landfill (50 mi), and shipping of recovered building materials to a recycling site (70 mi, on average). The entire building was assumed to be demolished. Energy needed for demolition was estimated by the LCA software based on bldg parameters and another report from Athena (1997) for steel buildings demolition energy.

3. RESULTS

The results of the environmental impact assessment in each life cycle phase are presented in Table 1. Transportation impact in every phase is included as an asset to this study. Interestingly, results show that the transportation contributes 80% and 70% of the GWP and Acidification Potential (AP) respectively to the total life cycle impact during construction phase. At the End of Life phase, this ratio represents 43% of GWP and 80% of the AP. In fact, the highest impact of transportation

	Manufacturing			Construction			Maintenance			End - Of - Life			Operating Energy		Total Effects
	Mat'l	Transp	Total	Mat'l	Transp	Total	Mat'l	Transp	Total	Mat'l	Transp	Total	Annual	Total	
Fossil Fuel Consumption MJ	2E+07	885301	2E+07	262351	971062	1E+06	1080278	27868	1E+06	581526	378290	959816	6196594	5E+08	5E+08
Weighted Resource Use kg	1E+07	22086	1E+07	6171.7	22881	29052	81587.8	660.24	82248	13695	8913.4	22608	481718	3E+07	4E+07
Global Warming Potential (kg CO2 eq)	2E+06	65866	2E+06	18099	72689	90788	72099.3	2069.6	74169	37916	28318	66234	595552	4E+07	4E+07
Acidification Potential (moles of H+ eq)	777996	21723	799718	9730.4	22926	32657	45847.6	659.59	46507	2102.1	8931.3	11033	227304	1E+07	1E+07
Eutrophication Potential (kg N eq)	597.07	22.568	619.64	6.7945	23.749	30.544	17.669	0.6837	18.35	1.4434	8.4377	9.8811	11.4504	687.02	1365.4
Ozone Depletion Potential (kg CFC-11 eq)	0.0064	3E-06	0.0064	3E-11	3E-06	3E-06	4.6E-05	8E-08	5E-05	2E-06	1E-06	3E-06	1.9E-07	1E-05	0.0064
Smog Potential (kg NOx eq)	5738.5	487.64	6226.1	204.12	511.71	715.83	308.857	14.739	323.6	27.012	199.34	226.35	132.651	7959.1	15451

Table 1: Breakdown of Environmental Impacts by Life Cycle Stage

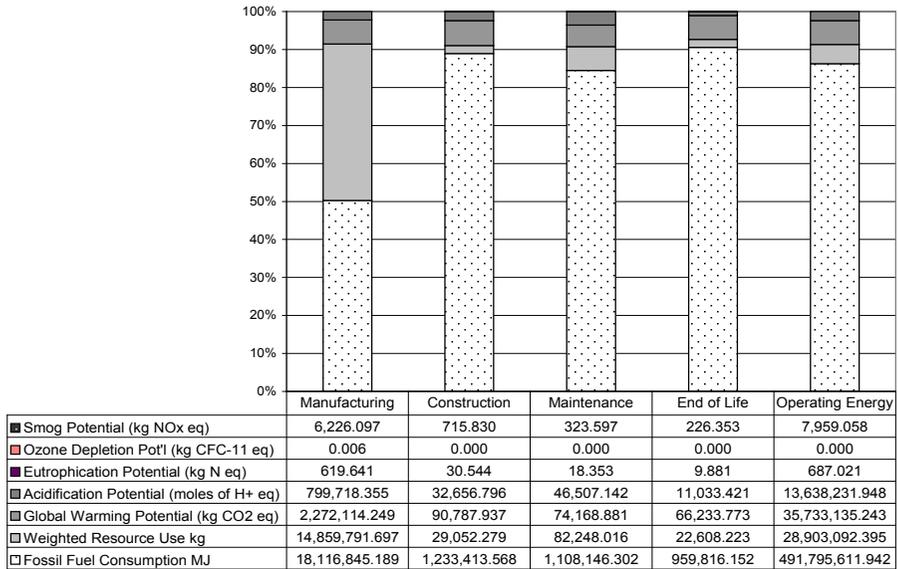


Fig. 1: Environmental Impacts by Life Cycle Stage

with higher ratios to the total phase impact is concentrated during these two phases; construction and end of life. This supports the argument of using local materials in building construction. Fig.1 shows the proportions of each life-cycle phase in every impact category with the associated numbers. Fuel consumption in MJ has a notable 80% or more in 4 life cycle phases with exception in material manufacturing phase in which it constitute 50% of the whole impact in that phase. This is consistent with most previous studies to show the significance of impacts due to fuel consumption. GWP seems to have a consistent ratio of 7% in all life phases. Resources use (kg) logically happens during manufacturing represents 40% of impact in that phase and another 10% in the maintenance where some of building materials are replaced. Acidification comes next to GWP at almost 3% in each phase. Looking at the same information in Fig. 1 from another perspective, Fig. 2 lays vertically the bldg phases to assess the contribution of the bldg phases to each impact category. It shows that bldg operation phase is responsible for 90%+ in 3 categories; fuel consumption, GWP, and acidification potential while this ratio decreases to

45% and 40% respectively in Eutrophication Potential EP and Smog formation impacts throughout the bldg life cycle. These two potential impacts tend to be released almost equally during manufacturing and operation phases. About 5% of smog is caused by construction phase.

The study found the summer smog impact of materials manufacturing and operation phases to be the largest contributor sharing the cause of smog formation at 40% and 50% respectively (fig.2). This study along with very few others (Tekes 2000) touched the potential of this important impact category.

4. INTERPRETATION OF RESULTS

4.1 BUILDING MATERIALS MANUFACTURING

Fig.1 shows that the greatest contribution to overall impacts in the manufacturing phase comes from the extensive use of fossil fuel impact (45%) in the manufacturing processes of the construction materials (steel, concrete, aluminum, glass, etc) that are required for construction. The resource depletion in this phase also represent 45% due to all virgin materials that are used and processed from the nature. GWP and AP represent the rest of the impacts at this phase at 10% mainly due to the releases from fossil fuel use in that phase.

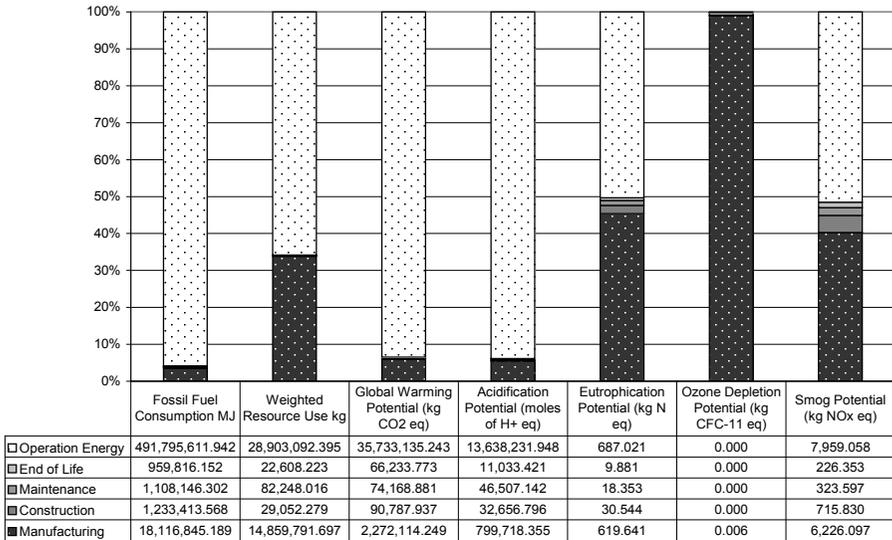


Fig. 2: Contribution of Bldg LC Phases to Each Impact Category

4.2 CONSTRUCTION

Fig.1 shows that in the construction phase, the use of construction equipment is the only life-cycle element with significant impacts (90%). That is due to the fuel and electricity used during the erection of the bldg. The other 10% attributed to GWP and AP with small fraction attributed to EP and Smog impacts.

4.3 OPERATION /USE

The operations phase dominates life cycle energy consumption. Table 1 shows the building operational demands over a 60 year life span, representing 96% (4.92x108 MJ) of the total life cycle energy. This ratio is off 2% of other studies in the same climate at 97.7% (Scheuer 2003). Almost 90% of life-cycle impacts in the use phase caused by electricity and natural gas used for heating in cold climate like Michigan.

4.4 MAINTENANCE

This phase comes second to manufacturing in terms of resources use where several parts of the buildings are replaced or renovated. Ozone Depletion Potential ODP, albeit almost negligible in the study, most of its causes are concentrated in the manufacturing and maintenance due to the VOCs released by paint manufacturing and the re-painting processes. The significance of the paint products has increased considerably from the original construction phase due to the frequency of repainting (every 10 years).

4.5 END OF LIFE

Table 1 and Fig.1 show that the demolition phase does not have significant impacts in the overall life cycle, except for the Eutrophication category (2%) and Smog (4%). Transportation of the waste material to the landfill produces most of the impacts in this phase.

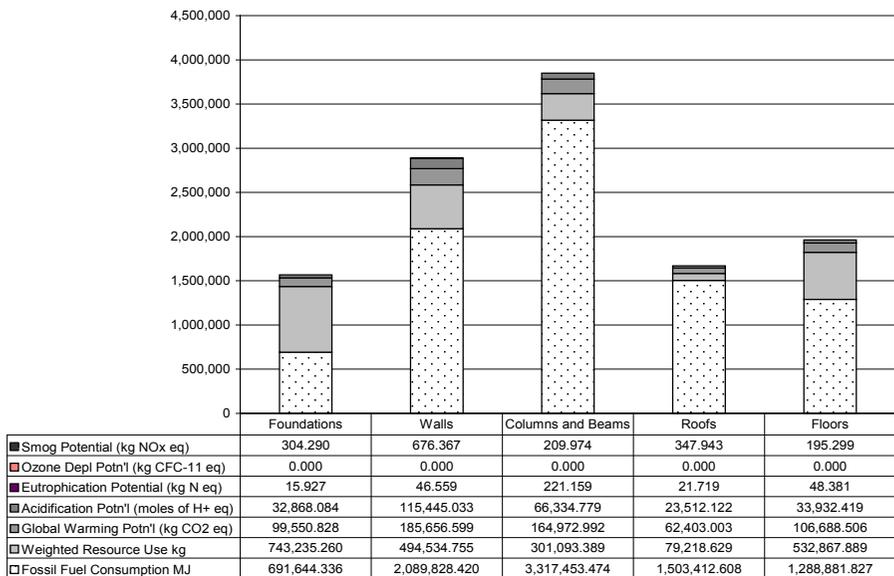


Fig. 3: Environmental Impacts by Building Assembly

4.6 LIFE-CYCLE IMPACTS BY BUILDING ASSEMBLY

In practice the building design process typically proceeds by building systems (design disciplines), not by chronological life-cycle phases. To interpret the results for the purposes of design management, an analysis of the result from the building assembly perspective is important. Hence, the life-cycle phases are divided into life-cycle elements, the elements belonging to different building assembly systems are grouped together, and the life-cycle impacts of each building system; foundations, walls, columns and beams, roofs, floors, are calculated.

Fig. 3 shows that the environmental impacts of the office life cycle are divided into 5 building components systems. The two systems that accounts for most of the environmental impacts are the columns/beams, and the walls systems.

This is due to the amount of steel (with its massive embodied and transportation energy) in columns and beams and the wide area walls system covers in the building facades. The most dominant impact category in the whole assembly is the fossil fuel used by each material (its embodied + transportation energy). Resource use is the highest in foundations and floors systems and then walls come third. That's due to the massive concrete weight and wide area both systems occupy. GWP is slightly more in walls (due to insulation emissions) than columns. AP is the highest impact in walls assembly due to some materials such as gypsum boards, fiberglass insulation, and vapor barriers which release SO₂ and NO_x during manufacturing.

5. CONCLUSION

The purpose of the study was to quantify and compare the potential environmental impact caused by an office building's life-cycle phases. The study also determined the life-cycle phases contributing most to the impact and defines the significant environmental impacts of the building. The study also examines the building assembly components that most contribute to its life cycle impact. All life cycle phases were found to have significant environmental impacts. However, most of the significant impacts were in the operation phase and the building materials manufacturing phase.

The results of the current study on the contribution of different life-cycle phases are consistent with results from previous studies. Most of the previous studies have emphasized the significance of

operational energy impact (Sheuer et al. 2003; Seo and Hwang 2001; Treloar et al. 2001; Thormark 2000), and some have also reported the possible significance of some building materials (Ochoa et al. 2002; Junnila and Saari 1998).

The study aimed at comprehensiveness; however, it included impact categories that others have not covered deeply such as summer smog, ozone depletion, and Resource use (consumption). Some limitation on impacts included biodiversity, and indoor air quality are not assessed due to the lack of data. Some other elements like office furniture, computers, construction of infrastructure, were excluded to focus the attention on modeling the building itself as simply as possible.

One of the main limitations of the study relates to the single-case study method used, because wider generalization based on a single case is not possible. However, the results of the study can be interpreted together with the results from previous studies. Another limitation of the study is the lack of other important environmental impact categories such as the construction wastes due to lack of data and modeling difficulty. The findings of this study support previous arguments that operation energy is a major environmental issue in the life-cycle of an office building, and that some building materials are also significant. This is typical for an office building in the U.S. For other countries, it is more difficult to generalize based on the results of this study. There are many regional conditions used in the calculations that could affect considerably the results outside the U.S. Building design, intensity of materials, construction methods, and intensity of energy use in the operation phase differ. Most importantly, there are differences in electricity generation and energy use (grid mix); e.g., a higher proportion of coal is burned in the United States, while Europe and Canada have a higher percentage of electricity from hydro (almost no emissions) and non-fossil fuels which will affect the final emissions especially the release of CO₂, SO₂, and NO_x to air. The study is also unique in modeling the building with the U.S. electricity grid which depends on coal as resource at 45% (DOE, EIA 2009).

Practical applications of the study's results could be directed to more environmentally conscious design and more facilities management of office buildings. Companies, owners, project and facility managers, and designers who are not yet familiar with environmental impacts could use the charts of the significant impacts and phases of the bldg where this happen to help them focus their attention on environmentally sensitive areas of design, construction, use, maintenance, and even demolition.

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Reaching Zero Energy in Florida's Hot Humid Climate

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ABSTRACT:

Once considered economically impractical and technology unfeasible, the zero energy home [ZEH] is now a reality, zero energy communities are on the rise and the world is poised to enter a new clean renewable energy era. In the State of Florida the hot humid climate presents certain challenges to energy efficiency, comfort and the development of ZEH. Vernacular and modern buildings built before the influx of air conditioning hold valuable lessons about designing in harmony with the climate. Research on ZEH in Florida has resulted in a wealth of useful information but many problems still remain. Most ZEH have been built with conventional site built methods and have reduced cooling loads with well-sealed, highly insulated envelopes. As a result, the homes are often closed off to the exterior and few innovations in cooling technology have been introduced.

This paper describes the research and design of a ZEH prototype for a hot humid climate, funded by a Florida Energy Systems Consortium grant. Taking vernacular architecture, modern architecture and recent ZEH research as points of departure the author describes the design and construction strategy for a ZEH prototype for a hot humid climate that will attempt to improve on current ZEH examples. The author argues that a Florida ZEH should have the potential to open up and take advantage of natural ventilation during the cool mild season and close during the hot humid season for mechanical cooling. A ZEH designed in this way would be more connected with the environment and the cooling load would be reduced with the use of natural ventilation also reducing the need for expensive PV panels and making the house more affordable. Prefabrication of ZEH can reduce waste associated with site building while shortening the construction period and reducing the overall cost of the house.

CONFERENCE THEME: Measurement

KEYWORDS: zero energy, sustainability, energy efficient, hot humid climate, renewable energy

INTRODUCTION

In recent years the dream of building houses that produce as much or more energy than they use has become a reality. Prefabricated home makers in Japan have offered net zero energy homes commercially since the late 1990's and entire communities of ZEH are being built around the world. In the state of Florida the hot humid climate presents special challenges for energy efficiency in buildings but the state enjoys one of the country's highest rates of incoming solar radiation making it a natural location for photovoltaic electrical generation. In fact Florida Power and Light [FPL] recently opened the DeSoto Next Generation Solar Energy Center the largest solar photovoltaic facility in the country. Early settlers had to live in Florida's sometimes severe climate without the luxury of mechanical air conditioning and the adaptations that their buildings made to the Florida climate are instructive when considering a new, energy efficient building paradigm for the state. As recent as the 1950's the so called Sarasota School architects were skillfully designing contemporary houses in tune with the Florida climate and lifestyle. Once air conditioning became the norm for creating comfortable interior environments, the common sense design features of vernacular Florida architecture and the Sarasota school were all but forgotten and houses were designed to optimize air conditioning systems rather than responding proactively to the climate. The once popular indoor outdoor Florida lifestyle was replaced by an indoor lifestyle that was quite separate from what happened outdoors. By the late 1990s an environmental crisis, high energy prices and the falling cost of PV technology all conspired to stimulate interest in sustainability and energy efficiency and research began on ZEH designed specifically for Florida. Research done since that time has generated many strategies for dealing with Florida's climate in energy efficient ways but little

has been done to integrate these strategies with Florida's climate or the Florida lifestyle. Flex house is a ZEH prototype designed by Team Florida¹ to revive the dream of the indoor/outdoor Florida lifestyle while responding to assets and demerits of the Florida climate. Flex house takes lessons from vernacular architecture, Sarasota School architecture and recent research on ZEH for a new kind of ZEH uniquely designed for Florida.

I. FLORIDA BUILDING PRECEDENTS

I.1. PASSIVE STRATEGIES IN VERNACULAR ARCHITECTURE

From the early 1800s white settlers began to trickle down from the northern states and establish homesteads in the Florida wilderness. Their houses became known as cracker houses. Like most homesteaders at the time, the Crackers built walls by stacking pine logs on top of each other with notched ends that interlock with adjoining walls at the corners. Although the same type of dwelling was built across the country, the Cracker house had features that were unique adaptations to the hot, humid Florida climate. While in cold climates it was often much easier to place the logs directly on the ground or on a layer of foundation stones, the cracker house logs were raised on piers to protect the wood from rotting on Florida's moist, warm ground. In cold climates the floor was often made of earth but in Florida, where air movement is essential to thermal comfort and the longevity of building materials, the floor was framed in wood and raised off of the ground so that air could circulate under the building. Whereas the northern settler's dwellings had little or no roof overhang, the cracker house typically had a wide covered porch on one, two or three sides that shaded the building from the hot sun and provided a covered, exterior space for work or leisure. (Hasse 1992)

Cracker houses were built of wood and metal, materials with low thermal mass that are well suited to the Florida climate. Given that the Crackers were adapted to Florida's climate and their thermal comfort zone must have been several degrees higher than ours is today, one can imagine that the Cracker house with its wide shady porches provided them with a reasonably comfortable living environment. Meanwhile, the architectural style of choice of the high society people vacationing in Florida in the late 1800's was not the humble wooden cracker house but the masonry and stucco style of the exotic Spanish Mediterranean. With masonry walls and heavy tile roofs that absorb heat, small windows that inhibit ventilation and minimal roof overhangs that allow the sun to bake the masonry walls, these houses were the antithesis of effective passive solar design in a hot, humid climate. But despite its lack of affinity for the Florida climate, the Mediterranean Revival style [Med-Rev] is



Figure 1: Typical Florida Cracker House
Source: (Forest Capital State Museum 2010)

avored by many, to this day, for its image of substance and wealth. One important exception to the Med-Rev trend began in the early 1940's when a small handful of Ivy league trained architects brought their brand of modern, regional, functionalism to Florida to redefine Florida vernacular in a way that celebrated the region's environmental assets while responding to its climatic challenges.

1.2. PASSIVE STRATEGIES IN MODERN ARCHITECTURE

Columbia University educated Ralph Twitchell, a designer and builder, opened his office in Sarasota, Florida in 1936 after spending the early part of his career in New York and France. Twitchell saw Florida as a paradise and sought to design buildings that worked with and accentuated Florida's natural beauty. In the early 1940s Paul Rudolph graduated from Alabama Polytechnic Institute [API] and went to work for Twitchell. While in Alabama, Rudolph had studied the climatic responses of local vernacular architecture and those ideas were fresh in his mind when he arrived in Florida to begin working with Twitchell (Domin 2002). The combination of environmental awareness, construction experience, and design savvy of the Twitchell /Rudolph team led quickly to works that brought national attention to Sarasota and the uniquely Florida houses that the team designed. The houses were built in a distinctly modern vocabulary that was also distinctly regional. The deep overhanging eaves, absent in the Med-Rev architecture of the day, were used to shade the building and to make shaded outdoor spaces recalling the cracker house design. Many houses included outdoor rooms enclosed with screens. Large sliding glass panels or louvered windows allowed entire walls to be opened for ventilation and to expand the interior space into the landscape. A variety of shading devices including louvers and screens helped protect the windows and walls from the hot Florida sun. In many cases the louvers were adjustable to respond to various sun angles or weather conditions such as vertical storm shutters that pivoted up to become horizontal sun shading devices. The plans were often elongated on the east west axis to allow cross ventilation in rooms and maximum shading for walls. The relevance of the Twitchell/Rudolph houses today lies in their skillfully conceived passive responses to the hot humid climate and their open planning and clean modern aesthetics that continue to suit contemporary tastes and lifestyles (Howey 1995). As air conditioning became more prevalent in the 1950's however, the necessity for climatically responsive architecture in Florida diminished. With the exception of a brief period of revived interest in the Cracker house, little serious consideration was given to passive solar design and energy efficiency again in Florida until the late 1990s, when the Florida Solar Energy Center [FSEC] began its research on ZEH.



Figure 2: Indoor/outdoor space by Rudolph
Source: (Stanley Russell 2008)

1.3. ZERO ENERGY HOUSE RESEARCH IN FLORIDA.

In the state of Florida in the 1990s the increasing affordability of PV technology began to open the door to site based electrical generation which, along with solar thermal technology, takes advantage of the state's wealth of insolation. In 1998 the Florida Solar Energy Center [FSEC] began its ZEH research program in collaboration with the City of Lakeland municipal utility. The team constructed a 2400 sq. ft. energy-efficient photovoltaic residence [PVRES] and a standard model [the Control] with the same footprint and tested them both for more than a year. In one year, the PVRES home used 6960 kWh of electricity and had a PV system production of 5180 kWh. For the same year, the control used 22,600 kWh without any PV production. The yearly energy savings due to differences in energy efficiency of the two homes was 70% for the PVRES house. Deducting the PV system's production, the PVRES house's net energy use for the entire year was only 1780 kWh a 92% utility energy savings compared to the standard house. Perhaps even more important than annual energy use is the fact that during periods of peak electric demand, the PVRES house, due to the PV system, placed nearly zero net demand on the utility system. Both test homes have R-30 fiberglass insulation blown in the attic, but there are major differences in the building envelope and mechanical systems of the two buildings. The building envelope of the PVRES house features a 77% reflective white concrete tile roof. The control home's roof is made of conventional, 7% reflective gray asphalt shingles. When the outside summer air temperatures were at their peak the coincident peak attic air temperature was 91.4oF in the PVRES compared to 131.50 in the house with gray asphalt shingles. For solar control on walls and windows, the PVRES home has a 3 foot wide overhang around the entire perimeter of the building while the standard home has a one and a half foot roof overhang. The overhang of the PVRES home shades most of the wall and at least 75% of the south and east window area. In conventional residential construction in Florida, walls are insulated on the interior of the masonry walls exposing the exterior to the hot sun and ambient air temperature and allowing the masonry to store excess heat and pass it slowly to the interior spaces. Conversely, the concrete block walls of the PVRES home were covered with R-10 insulation on the exterior to keep the masonry from absorbing excess heat from the outside. The mechanical systems of the two buildings also had marked differences. In conventional Florida house construction the ducts and often the air-handler are located in an uninsulated attic space. In Florida, the attic sometimes reaches 130o F and studies show that heat transfer to the duct system can reduce the cooling capacity of the air conditioner by 30%. In the PVRES house the air handler and ductwork are placed within the conditioned space of the building. The PVRES home uses a solar water heating system with propane back up. The system consists of a forty square foot solar collector mounted on the south side of the home's roof. The control home contains a standard electric resistance 52 gallon storage tank in the garage rated to use

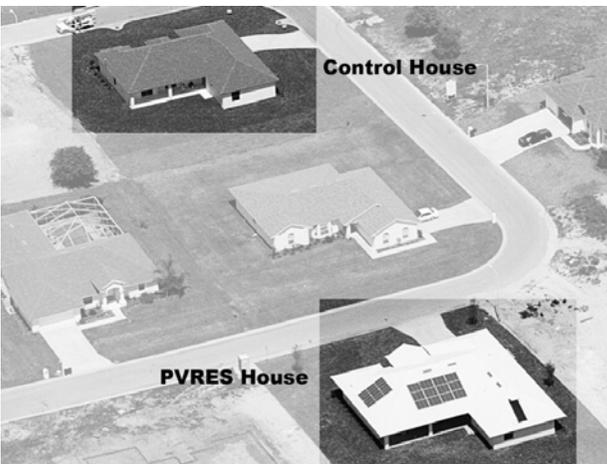


Figure 3: PVRES house

Source: (Florida Solar Energy Center 1998)

4,828kWh/year. The PV generation system for the PVRES was sized to provide power that would offset most of the daytime household electrical loads. Based on the predicted loads for a peak day, it was determined that a 4kW solar array should be installed (Parker 2008). The Lakeland project and several other research projects in the past 12 years have shown that a well-designed building envelope, energy efficient mechanical systems and appliances and a solar array for electric generation and hot water production, can be combined to produce affordable houses that achieve near net zero or net zero energy consumption in Florida. Team Florida took the lessons derived from research and vernacular and modern precedents as a starting point for the design of Flex House.

2. FLEX HOUSE DESIGN APPROACH

2.1. CONCEPT

FLex House is designed in a holistic way as a sustainable, flexible, modular, pre-fabricated, net zero energy house [ZEH] prototype that can adapt easily to different site situations and plan configurations. The house can be shipped on one truck and quickly deployed at the building site. The Flex house base module is designed for a young couple or a couple with a small child living in central Florida on a moderate income. As a family grows modules can be added to the base expanding living space as necessary.² While the emphasis in energy efficient houses in Florida in recent years has been to reduce heat gain with well-sealed and insulated building envelopes the result has often been an interior living space that is conditioned year round with little connection to the exterior climate or the surrounding site. Flex house is designed to open up to take advantage of passive cooling in Florida's mild weather months and close down to utilize highly efficient mechanical systems during the months of temperature extremes when passive strategies are not effective. This hybrid open and closed building type is conducive to a healthy indoor/outdoor Florida lifestyle and is reinforced by the design of the landscape, floor plan, building section, building envelope, and the choice of building materials and mechanical systems. The size of American houses has steadily grown since the 1970's. U.S census data shows that in 1973 the average house size was 1660 s.f. and by 2009 that size had increased to 2438 s.f. Larger houses mean that more resources are necessary for construction and operation [US Census]. A variety of space conserving design strategies give residents of Flex house an affordable, functional and comfortable living environment in an unconventionally small footprint.

2.2. PREFABRICATION

To be a viable housing alternative and to make a significant impact on our country's energy consumption, ZEH must be affordable for people earning a moderate income. Although individual materials and technologies affect the cost of home construction the building process itself is a more significant factor. Site built construction is inefficient in the use of time and materials and makes quality control difficult. Building homes in a controlled factory environment facilitates quality control and the efficient use of time and materials leading to the potential for a higher quality product at a lower cost with less waste going to landfills. Flex house is designed for prefabrication with dimensions that allow it to be shipped to the site in single truck increments corresponding to the size of the house. Sliding modules that fit inside of the main unit are deployed on site to allow a maximum square footage to be shipped on one truck. The single unit home concept emphasizes the viability of relocation, expandability, flexibility and recyclability to keep pace with the evolving American housing market and the demand for more sustainable building practices. The modular system allows expansion to accommodate a growing family or a new owner with different needs.

2.3. PLANNING

Abundant glazing and an uncluttered, open floor plan give the interior spaces a sense of lightness and openness with a visual and physical connection to the garden and surrounding environment. The kitchen, living, bedroom and bath areas can all flow together into one continuous space or they can be partitioned for privacy and thermal zoning. The entire north wall of the living/Kitchen area

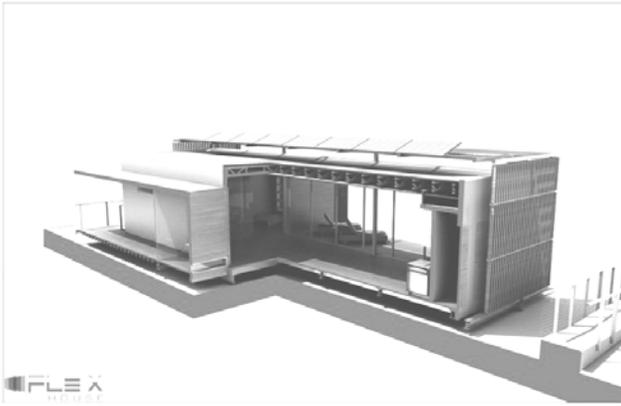


Figure 4: Section through FLeX House
Source:(Miguel Sanchez 2010)

is composed of sliding glass doors that can be opened to join the interior space, with the exterior deck and garden allowing for the hybrid open/closed building type. The plan includes many space saving features that create comfort within a smaller more economical envelope. A rolling kitchen island doubles as a dining table. A Murphy bed that folds up into the wall gives flexibility to the bedroom area which can also be used as a study or exercise area. A loft above the built in desk area can accommodate guests or children. A compact washer/dryer unit fits into a closet next to the bathroom. The bathroom can be partitioned into 3 separate zones for the shower, the lavatory and the toilet so that 3 people can use the same space at once and still have privacy. Mechanical equipment is located in a mechanical module and is easily accessible from the exterior of the house to give residents privacy and to prevent the interruption of daily activities when equipment needs to be changed or serviced.

2.4. SITE PLAN /LANDSCAPE

The FLeX House is elongated on its east west axis to facilitate shading of the building envelope. Because cooling is desirable during most of the year the house sits on the sun baked southern half of the site to free up space for a shaded courtyard on the house's cooler north side. A pedestrian spine along the west edge of the site connects the house's main entry to a street on the north or south side lending flexibility to the siting of the building. The building height and setbacks are designed to minimize shading of adjacent properties to ensure solar access to neighbours. The landscape design integrates landscape and architecture in a way that is utilitarian and aesthetic while also being environmentally responsible. The landscape provides food, shelter, wildlife habitat, microclimate modification, cleaner air and water, solar heat gain reduction and storm water runoff reduction. The plant palette consists largely of native species found within the region which are drought tolerant and insect resistant and require little water, maintenance and care. Various species of palm trees provide shade while allowing wind penetration of the site, ornamental clumping grass species and canopy trees placed within vegetated swales reduce storm water runoff and allow water uptake while providing food and substrate for other plants. Citrus trees, Muscadine and Scuppernong vines provide privacy, shade, and edible fruit. Saw palmetto provides privacy, shade, and fragrant flowers. Rainwater is collected from the roof and piped to a below ground cistern for use in irrigation of the landscape and for flushing toilets, reducing the demand on the municipal water system. To ease the impact of perennial water shortages in central Florida rainwater from the roof is collected in an onsite water feature and in an underground cistern where it is combined with Grey water from the kitchen and bathroom and used for irrigation of the landscape.

2.5. BUILDING ENVELOPE

Flex house is designed to function equally well throughout the year, combining optimum insulation for temperature differentials, resistance to air infiltration, daylight, and flexibility. SIP and stick built configurations were analyzed to find the best balance of efficiency, sustainability and economics. Both systems offer advantages over the other but in the case of the Flex house design, stick built construction was chosen for its strength, economy and sustainable aspects. Because of the low temperature differentials between indoor and outdoor air in Florida, insulation values in walls and floors can be relatively low. The roof is subject to very intense sun and heat build-up so the highest insulation value would typically be used there. Exterior finish Materials were evaluated and selected based on durability, energy efficiency, recyclability, maintainability, origin and economy. In Florida's high heat and small diurnal temperature range, materials with high thermal mass store heat and put extra load on AC systems. Light materials with low thermal mass and high reflectivity are preferable. Because of its low thermal mass, reflectivity, durability and economy, corrugated metal siding was chosen for the exterior walls of Flex house. Cypress is a locally grown wood that has a natural resistance to weathering and also possesses the other desired characteristics so it was chosen as a second exterior finish material. Traditionally, insulated glass has not been used in Florida because of the initial cost vs. payback comparison in the mild climate. For economy, Flex house has low-e, single pane glass throughout but more research is necessary to determine the efficacy of using insulating glass.

2.6. NATURAL VENTILATION

Flex house is designed to take advantage of Florida's mild seasons with passive cooling through natural ventilation instead of relying on energy consuming mechanical systems. Passive cooling begins with the site plan and vegetation which creates shade and cools the air before entering the house. FLeX House makes a strong connection between indoors and the landscape with carefully placed fenestration and sliding glass panels that allow the house to open out inviting air movement from across the site and through the house. Ceiling fans throughout the interior help to create air movement on days when there is no breeze. Raising the building off of the ground and ventilating the crawlspace helps to mitigate the negative effects of ground moisture, insect intrusion, and radon gas.

2.7. SHADING

Throughout the year the majority of heat gain in central Florida happens through the roof where attic spaces can reach temperatures exceeding 1400. The Florida Cracker house, homes designed by the Sarasota School, and FSEC research all demonstrate that shading is a critical strategy for reducing heat gain in Florida houses. To test the effect of building envelope composition on heat gain we constructed 3- 8'x8'x8' test modules each having a different skin configuration.³ The test revealed that complete shading of the roof and walls resulted in the greatest reduction in heat gain. Flex House incorporates an umbrella like outer structure composed of cypress wood louvers and photovoltaic panels that shade the roof and walls minimizing heat gain through the building envelope. The open space between the umbrella and the building envelope ventilates freely and prevents the build-up of hot air typically found in attic spaces. Movable shading devices give the umbrella the flexibility to allow sun in for passive heating on cold winter days.

2.8. MECHANICAL SYSTEMS

The Flex House engineering approach combines conservation measures with cutting edge technologies in a system uniquely suited to the central Florida climate. Flex house uses a combined system of photovoltaic panels and solar thermal concentrating panels to optimize the energy conversion system. The exterior walls and roof have a relatively high reflectivity to serve as a radiation barrier. Louvers in the umbrella structure allow indirect light to penetrate for day lighting but prevent direct solar radiation from reaching the walls. The HVAC system consists of a small air-cooled chiller



Figure 5: Indoor/Outdoor connection
Source: (Jean-Frederic Monod 2010)

and solar thermal panels serving two interior fan coil units that circulate air via ducts to the living spaces. Movable interior partitions between the sleeping/office area and the living area allow the wall to be opened or closed creating two distinct thermal zones. The HVAC system conserves energy by responding to the seasonal temperature and relative humidity fluctuations of the individual zones and the residents are able to regulate the temperature in each zone according to their needs. Flex house employs a solar thermal system to generate hot water for use in the house and for space heating. The water based HVAC system allows simple integration of hot water from the solar thermal panels into the space heating system. Hot water end uses like showers, sinks, dishwasher and washing machine are also supplied by the solar thermal system. The system is composed of two 4'x8' solar hot water collectors mounted on the umbrella connected to an insulated water tank. When there is sufficient heat to be drawn from the collectors, the controller automatically activates a pump which pulls cooler water from the storage tank through the collectors to be heated. Once heated, the water is pumped back down into the storage tank for consumption. This process continues as long as there is heat to be drawn from the collectors. When there is little or no sun, a backup heating element self-activates to provide ample hot water for the house. In this system a thermostatic mixing valve is used to ensure the proper supply temperature to the end uses regardless of the tank temperature, allowing the tank temperature to stay around 160 F0. In order to provide water to the fan coils at the desired temperature, a thermostatic mixing valve blends water from a warm tank and a cold tank. The cold tank is maintained at 55°F by the chiller. Waste heat from the chiller is used to heat the warm tank with additional heat provided from the solar thermal storage tank. A valve and control system determines whether to circulate chilled or hot water to the fan coil units. Chilled water is sent to the storage tank in the early morning when the chiller can run more efficiently due to the lower outdoor temperatures. The water is allowed to rise to a certain temperature according to the season and then cooled back down reducing cycling and allowing the chiller to remain off as long as possible during periods of peak electrical demand and higher ambient temperatures.

In Florida, where average relative humidity hovers around 75% during most of the year, dehumidification is crucial to creating a sense of thermal comfort. Flex house employs an innovative, liquid desiccant duct system connected to an *energy recovery ventilator* [ERV] to dehumidify incoming air and reduce the cooling load on the chiller and fan coil units [Oberg, Goswami, 1992]. The ERV exchanges exhaust air from the inside of the house with external supply air allowing fresh air to enter the house in a controlled manner. This is im-portant for maintaining indoor air quality. The air leaving the house passes heat to and from the incoming air, reducing the heating and cooling loads allowing the chilled/hot water system to run more efficiently. The liquid desiccant system

improves efficiency of the HVAC system by removing moisture from the supply air allowing the fan coil temperatures to exceed the dew point while still maintaining good indoor air quality. The Flex house HVAC system is designed to maintain a time-averaged interior dry-bulb temperature between 71.0°F (21.7°C) and 76.0°F (24.4°C) and a time-averaged interior relative humidity below 60.0% in all thermal zones. To keep energy consumption at a minimum, efficient appliances are essential. Flex house is equipped with energy star rated, smart grid appliances that communicate with each other to prevent multiple high draw appliances from turning on at the same time, reducing spikes in electrical demand. Low flow fixtures are used in the kitchen and bathroom to reduce water consumption and also reduce the energy required to heat water.

2.9. ELECTRICAL

Flex house utilizes both, a grid connected Photovoltaic array and a standard grid connection to provide all of its electric power. The grid connected system eliminates the need for expensive batteries used in standalone PV systems and allows for a give and take from the power utilities that results in a net zero electrical demand from the utility when averaged over the course of a year. Flex house draws electricity from the utility at night or on cloudy days when the PV array is not generating enough electricity to power the house and sends electricity back to the utility company when the PV array is producing more than the house needs. To facilitate periodic maintenance of PV equipment in a way that minimizes disturbance to the occupants and the building, the solar panels are mounted on the umbrella structure separate from the building envelope. Until recently PV systems used a single *central inverter* to convert DC power from the PV array into AC power that can be used in common household appliances or sent back to the utility company. Recent developments in *micro inverters* allow power from each PV panel or pairs of panels to be converted to AC directly, eliminating potentially hazardous high voltage DC lines from the system. Inverters operate with mean power point tracking [MPPT] that identifies the best combination of voltage and amperage for the panels to run at peak power. With a central inverter, the MPPT is applied to the array's performance as a whole so some of the panels are forced to perform below their capacity, resulting in wasted energy. Micro inverters optimize performance for each panel so that all panels perform at maximum output improving the overall efficiency of the array. In the micro inverter system, if one panel is covered with leaves, gets dusty, or is shaded it will not affect the output of the other panels. Flex house utilizes one micro inverter for every pair of panels in a 20 panel array that is rated at 4.4 kW DC.

Energy efficiency is the key to keeping the photovoltaic array as small as possible thus making the house more affordable. Flex house includes the most energy efficient appliances available along with compact fluorescent, LED, and day lighting to minimize electricity demand. Solar thermal panels for heating water and space heating further reduce the need for electric or other power sources. Because energy efficiency is also related to the operation and monitoring of building systems, Flex house will incorporate whole building systems control and diagnostic software that monitors more than 35 channels of data (i.e. temperature, humidity, power, occupancy schedules, window operation incidences, etc.) Most systems will be operable by cell phone or other portable electronic device. Accessible wire chases will allow data cables to be upgraded as necessary.

CONCLUSION

Many breakthroughs have been made recently in ZEH and clean renewable energy technologies that will inevitably lead the way to widespread implementation of zero energy houses and zero energy buildings in the near future. In Florida where the insolation rate is one of the highest in the country ZEH powered by PV systems that will also charge electric vehicles are undoubtedly coming in the near future. To build the most efficient, economical and comfortable houses that promote a healthy lifestyle a holistic design approach is necessary. Unlike ZEH or near ZEH that have been built up to this time in Florida, FLex House is designed with a comprehensive view of the environment, climate, lifestyle, economics, construction processes, and technology and will serve as an example of how ZEH can be designed and built in the future. FLex House is scheduled to begin construction in the spring of 2011 and will be finished by early summer. It will be prefabricated as a single unit

and shipped to Washington D.C. for the 2011 Solar Decathlon before returning to the University of South Florida's Tampa campus where it will become a zero energy house learning center for the entire Tampa Bay area. In addition to a learning center, FLeX House will also be a living laboratory to test emerging ZEH technologies and sustainable building materials and systems for use in the Florida ZEH of the future.

ACKNOWLEDGEMENT

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ENDNOTES

- 1 Team Florida is made up of faculty and students from the University of South Florida, University of Florida, University of Central Florida and Florida State University and professional consultants.
- 2 The basic unit with two slide-out modules is 950 ft². Two of the units can be joined to make a 1900 ft² house or smaller modules can be added to increase size in 100 ft² increments.
3. Three modules were built for testing. The first had no skin treatment. The second had a ventilated skin made by furring out plywood with ¾" furring strips, and the third had a louver structure covering the top and sides. The three modules were equipped with heat sensors and set in the sun for one day. At the time of peek temperature the house

Intangible patterns in real space: using social science methods to enhance urban research in Egypt

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ABSTRACT:

While discussing form, function and energy has its value, it must be remembered that architecture is for humans. All significance, meaning and worth are for and determined by humans. As such, using methodologies from the social sciences can enhance architectural research by grounding it in approaches designed to study humans. To illustrate this, an example will be used from the author's investigation on the changes in retail space in 20th century Alexandria, Egypt. Because of the methods employed, the author discovered several patterns of usage which were contrary to expectations. Two of these findings will be highlighted to show the benefits of a combined methodological approach. First, the character of this central city cannot simply be defined as declining because the social data shows an increase in usage and density. Second, the women's market addresses the need for female privacy not only through the architectural design but also through the patterns spatial usage.

CONFERENCE THEME: On Measurement, Social environment: what lessons can architectural research learn from the social sciences?

KEYWORDS: Anthropology, Ethnography, Retail, Gender, Egypt

INTRODUCTION

While discussing form, function and energy has its value, it must be remembered that architecture is for humans. All significance, meaning and worth are for and determined by humans. As such, using methodologies from the social sciences can enhance architectural research by grounding it in approaches designed to study humans and producing more rigorous research. Social Sciences are empirical studies of all aspects of human society and include anthropology, economics, education, ethnic studies, geography, history, political science, psychology sociology and women's studies (NSSA 2010). Using standard anthropological research methods in the investigation of the transformation of retail space in Alexandria, Egypt, the author discovered several patterns of usage which were contrary to expectations. Two patterns will be highlighted in this paper to show how using standard methods taken from social science research can not only enhance architectural research but also make the research more rigorous and ethical. As part of the sponsoring university's requirements, the procedures for this research were subjected to review by the Internal Review Board (IRB) to protect the participants by ensuring their privacy and evaluating any possible harm. These procedures include provisions about storage of data, obtaining consent, participant selection, interview procedures and the option to opt-out. Besides being ethically important, these procedures force the researcher to plan his/her methods as well as evaluating the participant selection process in order to reach the most appropriate study group.

The author expected to find that, like many other cities in the world, the exponential suburban growth caused the deterioration of the downtown shopping area. While the physical deterioration of the structures is apparent, the downtown area has not become a lifeless place. Instead, spaces which housed upscale shops, which have relocated to suburban malls or gone out of business, have been replaced by non-elite shops and vendors, and the overall density of shops has increased. Many of the older generation are nostalgic for the downtown of the past, yet they still frequent the shops in these areas. Young people, especially lower and middle class youth, also come to the city center to shop.

The author also expected to find that the women's market provided a gender segregated space which conformed to the Islamic "ideal" of separation of men and women. But through investigation, the author found that in the traditional markets, particularly in the women's market, men and women occupied the same spaces but did so following prescribed patterns.

This paper will show how following established research principles used in anthropology and sociology, employed in tandem with architectural research methods, can elevate the quality of research and dramatically increase the understanding of how the built environment is used and what it means.

I. PROJECT DESCRIPTION AND METHODS

I.1 PROJECT DESCRIPTION

The research used in this paper is part of the author's dissertation on the transformation of retail space in Alexandria, Egypt: 1920-2010. An interdisciplinary approach was particularly important in order to reach beyond conclusions about the changes to the architectonics of retail space and to understand how these changes have affected people and how people have influenced the nature of retail space. This time period was chosen because it covers several historical periods, each considered new, modern and liberating, including nominal liberation from British rule, World War II, establishment of the republic (actual liberation), socialist period, economic liberalization and globalization.

To investigate the spatial composition of retail space, plans, maps, field measurement, photographs, books and articles were used. But to examine aspects of the research question which are not evident in the existing built environment and written sources, social science methods were employed. A large component of this research involved interviews with ordinary citizens who live in or have lived in Alexandria as well as shop keepers, mall managers, architects and planners. Population and usage statistics were gained through observation and quantifying photographs. But the most important method was thinking anthropologically. This involved asking questions about the people rather than about the structure.

I.2 INSTITUTIONAL REVIEW BOARDS

Because this project involves Human Subjects, it required review by the Institutional Review Board (IRB) to ensure the protection of the research subjects. The project was given exempt status because the potential for harm was minimal but the process of submitting the documentation to the IRB was valuable because it forces the research to think about, articulate and evaluate his/her research questions, methods and potential for harm.

The first principle which is respect for persons means recognizing that research subjects are individuals capable of making their own decisions and having respect for those decisions. This reframes the relationship between architecture and individuals. People are not merely "actors" within the architectural space or acted upon by the architecture but they are individuals who make choices. In practical research terms, this requires informing potential participants about the nature of the research, obtaining consent and respecting a decision not to participate.

The second principle, beneficence means evaluating the risks and benefits for the participants. This seems obvious for medical and pharmaceutical research, but it is also important for architectural research. While the risk of harm is smaller, researchers need to recognize that even harmless questions can result in embarrassment or awkward situations. Additionally, how the information is stored, the security of the data and the privacy of personal information constitute potential risks for the participants. One of the unique risks of doing research in Egypt is the credible fear of secret police. Because of this, the study was designed around casual discussions and interviews rather than formal questionnaires which might have been viewed with suspicion.

The third principle, justice requires the assurance that participant selection is fair and balanced. This forces researchers to evaluate the participant selection process in order to ensure that the best population cross section is used to answer the research question. For this study, significant effort was expended in seeking participants who were outside of the author's comfort zone. This included people from the lower classes, those who spoke no English and illiterate or barely literate people.

Addressing these requirements and thinking about the research from a social science perspective altered the way the research was conducted. This paper will show how using human subjects enriched the architectural research by presenting two case studies wherein the results of the architectural methods produced a different conclusion from the anthropological approach.

1.3 CITY OF ALEXANDRIA

Originally founded by Alexander the Great in 331 BC, the city of Alexandria has been continuously inhabited but it has seen significant transformations over the millennia. Alexander established the city at the western edge of the Delta with a canal connecting the sea to the Nile. The city's port was protected by a long rocky island that contained the Lighthouse of Alexandria (Empereur 2002). Under Ptolemy II (r. 283 – 246 BC), a causeway called the Heptastadion was built connecting the island to the mainland. After the 12th century, the city was neglected and silt piled up along the Heptastadion eventually forming new land and transforming the lighthouse's island into a peninsula (Abdel-Salam, 1995). After the conquest in 1517, the Ottomans built the “new city” on the empty land of the peninsula and gradually, the rest of the population shifted into this area (Empereur 2002).

The modern city began when Mohammed Ali (r. 1805-1848), the ruler of Egypt, built his palace in Alexandria in 1817. Serious building began in the 1820s when Mohammed Ali initiated several ambitious building campaigns to create a modern European-style city. He built new docks, restored the silted up canal and encouraged foreign immigration. The center of the new modern city was the Place des Consuls which was designed by Francesco Mancini in 1934. This plaza, now called Mansheiya Plaza, is a long narrow square which was surrounded by large European styled block buildings and linked to the sea by a perpendicular plaza called Urabi Square. By the 1860's the city had spread far enough to the East to necessitate a railroad (Empereur 2002). The city has continued to grow West, South and East as allowed by the geography, but East was the direction of preference. Villas for the middle and upper class were built in the eastern suburbs but now they have been replaced by apartment towers as the wealthy new construction has moved further East (Abdel-Salam 1995). The current city has over four million people (CAPMAS 2009) and extends approximately 25 km along the Mediterranean shore but the total urban agglomeration is nearly 60km (Empereur 2002). The width of the city averages 3km and the widest point measures about 5km from the sea to the City Center Mall along the Alexandria-Cairo Desert Highway. Almost nothing of the ancient city remains and most of the existing urban fabric is from the 19th and 20th centuries. The city is very European in appearance with many of the significant buildings being designed by European architects (Awad 2008). Downtown Alexandria is centered on Mansheiya Plaza, the tram station called Mahatat Ramleh and the shopping street connecting them. Buildings in this area consist of ground floor space filled with shops and a few cafes and restaurants. Most buildings are 3-4 stories tall and the upper floors contain apartments and offices.

2.CASE ONE: DOWNTOWN DECLINE

2.1 DOWNTOWN DECLINE:ARCHITECTURAL APPROACH

Based on a study of the urban fabric in the city center in the 1990s, Hassan Abdel-Salam noted that “an average 80% [of buildings] are historic with valuable architectural styles and richly detailed facades.” (Abdel-Salam 1995) This was the shopping district and home to the finest shops and department stores (Ilbert 1997). Unfortunately, this area has suffered greatly in the past two decades and is in a state of decline. The elegant department stores are nearly abandoned, with their high end merchandise being replaced mainly by cheap import goods and their inventory greatly reduced. The stores themselves are in varying states of deterioration due to government sequestration and nationalization. As public entities, they have not received proper maintenance and several have been subject to destructive renovations and repairs (Awad 2010). Similarly, the other shops in the central business district have suffered from decline. The major factor depleting the downtown has been the suburban growth of shopping centers and malls. The first mall appeared in 1997 and was instantly popular (Ihab el-Khodairy 2010). After that a series of subsequent malls were built. These drew people out of downtown and began the suburbanization of shopping. About 10 years ago, the city

embraced the Western urban models and began to build new urban cores throughout the city and on the periphery. These were mostly commercial developments which appealed to local populations because Westernization has become synonymous with modernization. Alexandrians demanded this type of shopping because they were attracted by the large shops, international stores, large grocery stores and parking. The downtown suffered as a consequence and some parts of downtown were deserted. Store owners who recognized this trend and moved to the trendy areas or opened branches there have survived. But stores who failed to recognize this are struggling. This has caused a change in clients in the downtown area, from elites to lower class clients who are buying cheap products (Aref 2010).

An architectural survey of the city reveals a disturbing trend of wide scale deterioration. The problems can be categorized in to three broad categories: surfaces maintenance, distasteful infrastructure upgrades, and incompatible renovations. Most of the facades in the city center are covered by a thick patina of grime. More destructive than this are the infrastructure upgrades which at best ignore the architectural integrity and at worst destroy architectural details. For example: air-conditioning units and satellite dishes disregard any sense of order and are located at the convenience of the installers. Similarly wires and cables are strung chaotically on the facades. In some cases, waste pipes cut through lintels and cornices. But the most destructive changes are caused by “modernization.” Over the past 50 years individual shops have built their own “modern” facades at different points in time. These new facades are unrelated to the adjacent shops in scale, design and materials. They have no relationship with the building they are a part of and often disregard the original bay spacing. Bays have been subdivided, passageways have been occupied and shops have co-opted additional square footage. Thus the overall image of the heart of the city is one of decline. In reconciling the literary Alexandria with its reality Khaled Fahmy notes that “...the descriptions of modern Alexandria...is, in fact true: much of modern Alexandria is typical of a sprawling, third-world metropolitan mammoth whose streets are overcrowded, whose garbage is left uncollected, and whose neighborhoods are indeed noisy, dirty and smelly.” (Fahmy 2004)



Figure 1: Main entrance to Okelle Mensesce from Mansheiya Plaza showing adjacent shops encroaching on entrance and non-harmonious shop facades (2010).

2.2 DOWNTOWN (NOT IN) DECLINE: ANTHROPOLOGICAL APPROACH

While no amount of anthropological research will prove that Alexandria is a glittering gem of urban beauty, it will challenge the conclusion of decline. By looking at density, a strong case can be made the city center is not in decline but has shifted in character and is de-gentrifying. One example is the Okelle Monferrato, which is a mixed use building designed around a central courtyard which is located on the corner adjoining the two main plazas of downtown. Photographs from 1887 and 1920 show approximately 4 shops along the two public facades of the building (Haag 2008). Currently, there are thirteen shops in the same space and the large corner unit measuring 3 bays by 3 bays which is vacant. The Abu Ribia' restaurant has expanded into the neighboring space which is actually one of the main entrances to the courtyard and apartments above. Currently, the residual passageway is less than one meter wide. Similarly, in Okelle Menesce, another mixed used building which is located on the opposite side of the main plaza, there is an increasing density of shops and many have intruded on public space. On the principal facades, only two bays are unoccupied and all of the shops adjacent to the monumental entrances have encroached into that space. On the main plaza façade Kenz, a clothing shop extended its façade one meter into the entrance passage (See figure 1). On the other side of the entrance, Boom Boom, a jacket and bag was created from the end of the Bata Center shop to nearly the middle of the entrance. Other entrances are filled with lighting shops, sundry stands and clothing sellers. The density of commerce is further increased by the semi-informal venders located in the courtyard. There is even a permanent sign designating this space as Al-Suq Naha (Naha Market). In addition to cramming this space with racks and racks of clothing during the day, semi-permanent storage sheds constructed from scrap material house merchandise at night. Although photographs from 2004 show none of the current structures other than the sign (Saad 2004), two vendors report having "shops" there for 12 and 15 years and paying rent for their space. In terms of density of shops, this area shows that stores are getting smaller, increasing in number and owners are staking out new territory to create selling space because this location is viable.



Figure 2: Suq Naga located in the interior courtyard of Okelle Menesce. Structures in the center and right of photo are used to store merchandise at night and are rented from the building owner. Later in the day, all of these shops will open and merchandise will be displayed on the racks. The arch in the upper left hand corner is the back side of the entrance arch in Figure 1 (2011).



Figure 3: People crowded around mobile vendors in the city center with vehicular traffic passing behind them on Saad Zaghloul Street. Stores are illuminated and usually open until midnight (2010).

In terms of people, the central business district is also dense. Unlike dying American cities where downtowns are nearly vacant except during business hours, downtown Alexandria is alive with people from late morning until midnight and especially on weekend nights. People arrive by tram, bus, microbus and private car to cram the streets and sidewalks. On Thursday nights (the first weekend night), in the most popular areas, it is difficult to move through the sidewalk crowds, especially because mobile vendors display their goods on tarps on the sidewalks and in the streets. And while many informants discussed how they used to do all of their shopping downtown but now go to the malls, all informants still visit downtown for shopping. Some of the poorer individuals prefer to shop in this area because of the variety and price of goods. So the central business district has become neither vacant nor devoid of people and is still valued by the population even though it has changed from high end shopping to primarily popular goods.

By studying the central business district of Alexandria from a social point of view, one sees that in contrast to the poor state of infrastructure, it is still a lively space. Although not the high class district it once was, it is still extremely popular and provides goods, services and jobs to many people.

3. CASE TWO: WOMEN'S SUQ

3.1 WOMEN'S SUQ: ARCHITECTURAL APPROACH

Traditional notions of space in the Islamic world require the separation of men and women. The purpose of this is to protect women from sexual misconduct and impropriety. The ideal upper class woman lived all of her life in seclusion from the public world but this option was impractical for the majority of the non-elite women. Appearing in public tainted women's moral and social standing because both morality and class were intimately tied together (Hourani 1991). Even today, Anouk de Koning, an anthropologist working in Cairo notes that "the gaze" or being watched by unknown (and implied lower class) men is considered a "polluting and defiling agent that physically impacts the female body. [The gaze is] moreover, able to impute a bad reputation and suggest a lack of respectability (de Koning 2009)." Thus certain concessions are required to produce spaces where women without means can maintain respectability. One of these methods was the creation of the Women's Suq or market.

Zinqat al-Sittat, literally The Women's Squeeze because the space is so narrow and sells goods exclusively for women. It is located in the heart of the *suq* (market) district surrounded by markets



Figure 4: Entrance to the Women's Market, center and left. Showing density of goods for women including jewelry, `accessories, scarves and fabric. Note the proportion of men to women (2010).

for jewelry, house wares and fresh food. Like other Middle Eastern *suqs* (markets), the *Zinqat* consists of small shops along a corridor, but this *suq* was not originally built as a market. Initially, this is where the French stabled their horses. When they left in the beginning of the 19th century, Moroccan merchants moved in and transformed the space into a *suq*. The gates which closed off the *suq* have since been removed so there are no physical barriers between this market and the adjacent markets within the *Suq* District (Al-Ahram 1993).

The name, *Zinqat al-Sittat*, refers to the spatial quality found within this particular *suq*. It is typified by narrow passageways, some of which measure less than a meter and are further restricted by merchandise overflowing from the individual shops. The feeling of tightness is exacerbated by the relatively high "ceilings" of up to 4 meters which are created by a hodgepodge of awnings and tarps of varying permanence. Additionally, the profusion of colorful goods such as costume jewelry, scarves, lingerie, buttons, thread and ribbons intensifies the visual experience.

All of these physical characteristics combine to create a lively shopping experience within a "safe" place for women. Because it is located in the heart of the *suq* district and consists of such restricted passageways, there are no views in or out of the *suq* so it is visually private. Also, the social spaces where men hangout (coffee shops) are located outside of women's *suq* and are not visible from the *suq*. From this approach, one can easily conclude that the *suq* is a space for females because of the physical design and layout.

3.2 WO (&) MEN'S SUQ: ANTHROPOLOGICAL APPROACH

Alternatively, the results of anthropological study reach a different and more interesting conclusion. Of the people who occupy the *suq*, only 51% are women. The men are shop keepers, delivery men, waiters, and the occasional shopper. These men constitute nearly half of the population in the Women's *Suq* but interact with the space in a very different way. The shop keepers, most of whom are

men, are generally stationary, limited to the space of their shops or the space immediately adjacent. The delivery men go directly from the exterior streets and alleys to the individual shops. Similarly, the waiters delivering tea travel between distinct places – from coffee shop to patrons who are usually shop keepers. So within the Women's Suq, men's space is largely scripted with prescribed spaces and patterns of movement. Women on the other hand occupy the same physical space as men but move through the space at their own leisure and following their own agenda.

By combining the architectural and anthropological research one sees that both the physicality of the suq as well as the social patterns create a place which addresses the need for a private safe place for women to shop. So women's suq becomes a female friendly place not because of the lack of men in the space but the way in which men behave there. Because it is designated as a women's place, men do not go there unless they have a specific purpose – such as tending a shop, delivering goods or shopping for a woman. This means that there are no groups of idle men walking, gawking, or harassing. Women are protected from the polluting gaze of the street. Even though there are no physical boundaries or security guards, social controls make this a safe place.

The architectural research shows how the physical configuration of the spaces (including the types of merchandise sold) generates a female space but the anthropological research shows that the Women's Suq is not actually a female space but instead a place which is deemed appropriate for women because of a combination of the physical and social constructs.

4.CONCLUSION

From these two examples we can see how different conclusions can be draw depending on the methods employed. In the case of the deteriorating downtown, the architectural approach showed significant damage and deterioration. But from the anthropological approach one discovers that people are not retreated from this space but instead are filling it with an ever increasing density of shops and commerce. In the second case, the architectural approach shows how the physical structure of the women's market creates a safe environment for women to shop. But the anthropological research explains that the special character of the women's market does not exclude men in order to make it safe for women. Instead men and women coexisting in the same space but men's movement is scripted. Although the two conclusions in each of these cases are nearly opposite, they do not nullify each other. Instead, they enrich the understanding of the downtown and the women's market.

Architectural research is richer when scholars approach structures, spaces and cities anthropologically. Too often we architects use the methods we've seen used in the past or we too eagerly adopt new technologies for their coolness factor. Instead of being tool driven, research should be question driven. Sometimes from the most pedestrian methods such as counting heads one can draw profound conclusions. Other times high tech methods can elucidate age-old questions. Thus following established research principles used in anthropology, when employed in tandem with architectural research methods, can elevate the quality of research and dramatically increase the understanding of how the built environment is used and what it means.

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Resolving Form Generations through Analogue and Digital Human Simulations

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ABSTRACT:

Architectural investigation of forms through parametric equations and transcendental computational research is evolving the practice, development, and implementation of complex forms. Architectural concepts require adaptability to a variety of complementary human factor considerations including constructability, ecologically sensitive building systems, and human comfort considerations, that would benefit from the inclusion of human factor simulations of person with disabilities. The position of this writing supports the application of dynamic human factors modelling to transcendental computation data-based form generation for the development of advanced architectural forms, of which there are three potential long-term target influences. The first of these is the potential for multi-faceted transcendental computation data based forms in the development of ideas relating to the application of accessible solutions in architecture. The second is the collection of parameters relevant to code-based constraints in the development of human factors simulators, which contain data relative to variations in human physiology and cognition based on models of impairment and disability. The third is the review of concepts for developing human factor simulators to inform design choices respondent to issues of accessibility in the development of spatial relationships, and the performance of tasks in the generation of the two.

Currently a digital model can be evaluated for conflicts and use variables of human factor simulators programmed to engage the representation of environmental conditions data.¹ By developing architectural concepts from software which are capable of studying whole-body, musculoskeletal human simulations of persons with varying physical, cognitive, and psychological capabilities, complex computational data-based forms can evolve to benefit people in environmental conditions that are currently underserved. The testing of patterns of use for mechanical equipment have successfully been developed based on anthropometric analysis and equal ergonomic simulation.² The intent of this research is to develop the premise that a complex computational based architectural form can be generated from parameters of physiological and ergonomic ranges through simulation of use patterns based on information available in the building code and influenced by the definition of environmental use. The use of rapid prototyping tools and CAD/CAM technologies for development and evaluation of the resultant generated forms would be for the synthesis of virtual concepts with allotted physical tolerances to validate compliance, while simultaneously evaluating fabricating processes for conditional ease of assembly and performance.

CONFERENCE THEME: Embracing Humanity

KEYWORDS: Egress, Physiology, Behavior, Simulation, Design

INTRODUCTION

In finding ways to incorporate the capabilities of assistive technologies into better design solutions for those whose physical condition clearly presents greater difficulties, informs the functions of independence in everyday life. The human body is in a constant state of flux; evolving to adhere to the environment and devolving due to age. These changes introduce new design dilemmas and constraints that the design of dynamic transitional forms can respond to. This research into the application of human functional data to computational based form generation has three potential long-term influences. The first of these is the potential of collecting computational data in the development of simulations relating to accessible solutions in architecture. The second is the creation of variables relevant to code-based constraints in the development of human factor simulators; those which contain data relative to variations in human physiology, and those which are cognition based, on models of impairment and disability. Finally, is the review of concepts on developing human factors simulators to inform design choices in the development of spatial relationships and the performance of tasks in the generation of the two.

The connection of the variables of postural and motion-based spatial arrangements as gathered from simulations within a design and fabrication tool in the generation of the form, are useful in evaluating variations in the tolerances for both that address the fluctuation in code based design guidelines (Table 1). Critical compliance variations in model codes would actively adjust the model to generate forms that are responsive to “live” changes. These changes would be tracked to catalogue the effects on each stage of the process, with the intent of decreasing the “tolerance for error”³ while increasing the active capability for changes throughout the project phases.

These tolerances, produced from examination of analogue prototype testing, will determine areas where a range field is more suitable than an exact dimension. This will allow the form to have a less arbitrary response to conditions, and will allow for the evaluation of stronger solutions by querying the selection of a series of systemic equations with an active global influence. In areas of importance, where greater focus on motion and discomfort simulations are needed to evaluate distortions, the query will employ more variables, and in less codified variable situations, the program will rely on stronger external aesthetic forces.

Designs using these variables as a guide would reflect with greater ease the wide variation of human needs. Investigations through qualitative measures, expressive of an understanding of user variations, would match the query with the theoretical potential of complex virtual solutions. An example of the proposed development would be solutions for egress from vertical spatial transitions and the analysis of use in the generation of a wall and stair assembly as a transitional form and the consideration of its expression along all three axes. The need to provide options in exiting vertical structures to the ground plane, that allows types of egress based on varying physical ability, would be evaluated as an active connection between variables of the distortion and parameters of safe transition between levels. Studying these differences in the progression of form, when the wall or stair distort singularly along different axes versus when connected to other environmental conditions including human functional data, will aid in understanding the degrees of latitude which can be incorporated into the model constraints to ensure compliance without restricting the generation of a form.

1.1. THE PURSUIT OF THE FORM FOR FUNCTION

The potential for anthropometrically based design solutions to provide choice at multiple design scales is based on several factors. These factors include a design, which is consciously aware of the target user(s) ability to wilfully communicate, move through, or engage the environment. This should be accomplished without encountering measures that prevent the fulfilment of personal independence or collective participation due to a lack of variety and adaptability by the environment.⁴

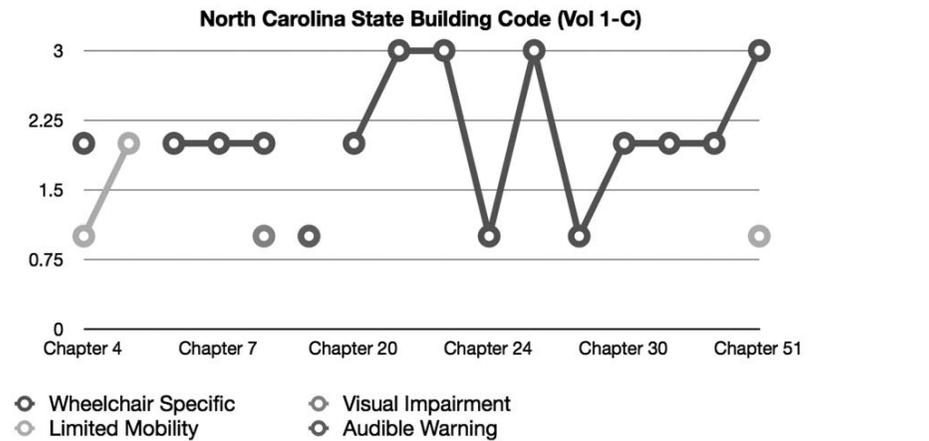


Table 1: References to specific disabilities in examples of state and national codes.

This healthier environment does directly relate to greater light, cleaner water, fewer emissions, and a more natural setting by which we can live our lives, but equally relates to ability and the tolerances for the variation in our physical stature and ability.⁵ These directly relate to our psychological strength, and ability to relate to the environment.⁶

Environmental deviance is appreciated for its variability where the intended spatial reactions are different from what is proposed. To a certain degree, this requires an acceptance of social deviance from the intended order or patterns of expected use (Table 2, Figure 2). In the case of passage as a means of egress from a building, the designer assumes that the intended users will be coherent and calm enough to navigate out of the building and those exiting with impairments, such as visual impairments, will be patient and calm enough to read Braille signage directing their way. It is therefore plausible that there is a need for resolution of these issues based not upon the capabilities of the mean user type, but rather from the extremes of the spectrum to address a more inclusionary set of solutions. The realization of design as a potentially alienating action or as segregating in providing equal safety based upon use, is a factor of inappropriate functional deviations. By addressing the removal of the known social separators in places where separation is detrimental to positive interaction, life-safety design dilemmas can be resolved before implementation.

The transition of a process-driven industry, from conceptual work and generation to the manifestation of artefact is through an understanding of form in relationship to a spectrum of human factors. This study explores this by examination of the environment's conditions through dynamic computer simulation. The exploration of computational data as a means of searching for opportunities in design which are both hidden and apparent, bridges affordability and accessibility within aesthetic and design sensibility. The opportunity to provide development criteria for creating a continuous physical connection to place reinforces universal accessibility, and satisfies an adaptive culture of diversification. The architect holds a "primary obligation and responsibility" to operate in the creation of the components of the built environment, and to safeguard health, safety, and welfare as defined by each state's general obligations of practice.⁷ It is also becoming of architects to concern themselves with the creation of physical environments that maintain beauty and order while serving the spectrum of elements related to human function.

PARAMETERS

- 10 occupant-proxies exit into the fire stair per floor
- 1 disabled-proxy waits at the rescue area on every floor
- 1 fireman-proxy enters at the base of the stairwell / floor

ASSUMPTIONS

- Proxies enter the stairwell 0.8s after the previous proxy
- Occupant-proxies travel down the stair at 45 in/sec (plus or minus up to 30%)
- Fireman –proxies travel up the stair at 35 in/sec (plus or minus up to 10%)
- Faster fireman-proxies will tend to rescue the disabled-proxies on the highest floors
- Proxies will avoid colliding with other proxies. When two proxies travelling opposite directions must pass each other, they will tend to move to their respective rights, if possible. Proxies try to avoid areas of extreme congestion, and will occasionally move wildly to extricate themselves if pressed.

These relationships are continuously in flux between analyzing the architectural artifact and architecture as the entirety of the built environment based on communities and regions. Experimentation with "off the shelf" products in the study of digital and computational based technologies, and in the generation of forms and multi-axis fabrication techniques, will help to evaluate conflicts with future versions of generative manufacturing techniques. Currently, the building industry process of suppliers distributing field-assemble components is inexpensive enough to compete with in-house fabrication. As the industry of in-house fabrication grows, I believe this will move from on-site assembly to on-site multi-axis fabrication and material based generative manufacturing techniques.

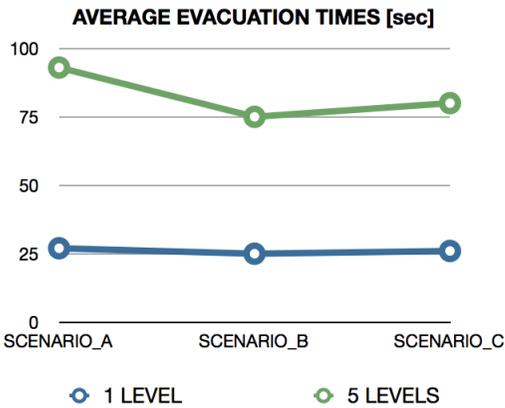


Table 2: Performative evaluation of egress patterns related to search and rescue one flight of stairs
 **(*Independent Study by university of Michigan students Parke MacDowell, Diana Tomova*)

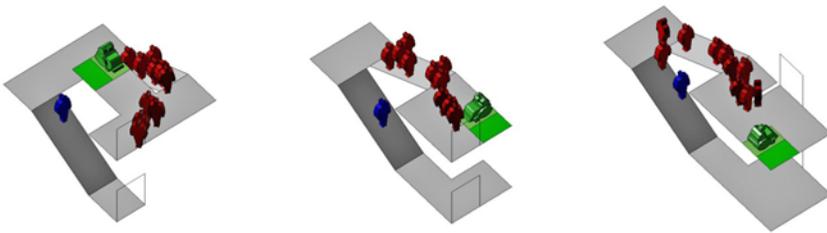


Figure 1: Performative evaluation of egress patterns related to search and rescue (one flight of stairs)

Mostly, the innovation in conceptual building processes will be associated with advancements in techniques for resolving design issues around the variables of human function needs.

Humanistic interface with object and spatial void is relevant to perception and the engagement of the user.⁸ The possibilities for calculated computational modelling to resolve the issues of difference in human stature and access is a proving ground, evidencing that design can have a positive impact on human health. The use of techniques inherent in ergonomics as form generating parameters to inform the computational generation of architectural armatures is similar to the general practices of industrial designers who, in developing body styling that is responsive to environmental factors related to drag or other inhibitors, study how to resolve these technical issues through design. It is possible to understand the applicability of this technique to the field of architecture.

1.2. SPECIFIC APPLICATION OF COMPLIMENTARY EXPERTISE

Barriers affecting mobility impede connectivity beyond the physical restrictions of personal human impairment. The observation and documentation of human patterns of use to influence the forms that shape environmental mobility has been a key tool in understanding the social independence of a population.⁹ Deliveries, strollers, and bicycles are all presented with similar difficulties in transiting across level changes as persons with limited physical abilities. Issues related to means of egress directly impact the health and safety of those in this category with limited physical abilities, exemplifying the need for level or limited slope exiting in emergency situations to prevent injury and loss of life in low-rise buildings. Human factor simulations based on variations in physical ability to study the range of possible users in scenarios associated with multi-story buildings (Figure 2), and can help a designer prepare alternative solutions in preventing injuries along a path of travel.

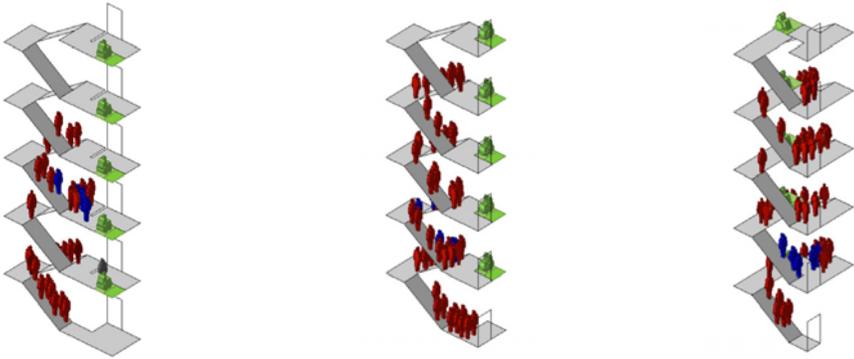


Figure 2: Performative evaluation of egress patterns related to search and rescue five flight of stairs

The selection of appropriate levels of information based on what our brains and bodies are capable of comprehending in emergency situations is another opportunity of study. The simulation of variables a user would experience based on immersion in a world of sensations, while populated with egress decisions. Many of the experiences tend to be directed towards singular sensory experiences, with very few balancing multiple sensory perceptions.¹¹ This changes in emergency situations, where the primary focus remains visual stimulation for orientation, often with disorienting audible warnings, and conditions that may affect orientation due to smell (taste) and touch.¹²

A sense can be defined as a general conscious awareness. By studying this awareness and understanding the corresponding behaviour, designers can define a set of variables for simulation through a variety of preceptors for understanding. The general premise would allow for a design to evolve from this perception; specifically, how the variables would simulate random human interaction based on the investigation of sense stimulation as a component of human factors simulation (Figure 3). The studies would produce a set of variables that could potentially enhance secondary orientation by senses in an equal manner as the physical one.¹³

The second half of the study is concurrently examining varying reactions and disorientations with light, sound, and touch. The simulation of patterns of behaviour in an active virtual model in association with the various qualities of materials and the resulting associated behaviour can give credence to placement and variations in form when rationalizing an architectural concept. The interpretation of the material as a variable based on the transitions between materials and their perception in various situations develops a virtual language of simulations of multi-axial and proximal relationships in simulating human awareness and orientation. The purpose of this is to inform the simulation of the barriers a user may encounter and randomly generate options in their orientation so that the designer can consider degrees of flexibility in the development of the form to affect its understanding.

By conjoining virtual spatial awareness with variations in sensory ability and considering the choice

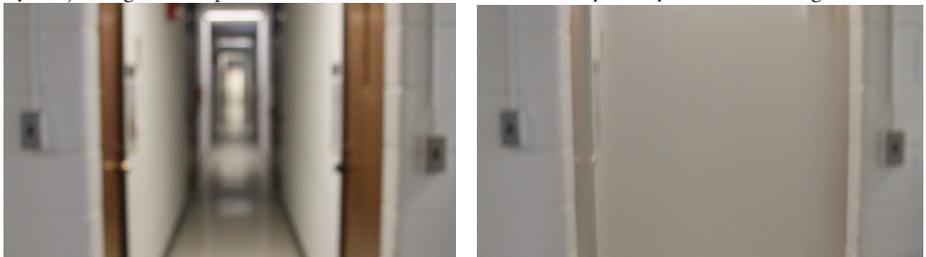


Figure 3: Visual simulation of macular degeneration through videography

of preferred environmental responses, design dialogue becomes intended experience with the body and mind, which supersedes subjective awareness and aids resolution of conflicts over intent. The collection of these results is an inventory of understanding, advancing the database of perception and individual experiences in developing computational design criteria as related to varying physiological and psychological differences.

1.3. CONCLUSION

The physical and psychological capabilities of the human body change, and the flexibility of an environment to adapt to these changes through dynamic architectural forms could advance the shaping of the built environment. The capability of a design solution to adapt to the variation in physical capabilities by providing variations for equal use and cognition is an investment in the longevity of its use. This does not mean we wipe away the necessity of barriers that serve to provide security and control, but only that we find solutions that at least relate to the diversity and variation inherent in human physiology.¹⁴

Building Codes are only a part of the process of understanding the variables and decisions addressing the varying physical limitations of the built environment. By encouraging negotiable environments respondent to the pursuit of a greater quality of life for all, we might see ourselves as dynamic beings in constant transition, seeking to align our environment with our own changes, while the level of our capabilities diminishes around us. The strengthening the bonds between the critical thinking processes and the design thinking process itself fosters innovation, yet innovation without experience is detrimental to the goal. Collaboration between form generators and human factoring simulations addressing disability as primary language component for developing innovation in design can broaden the beauty of the solutions it produces.

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Four Theorems of African Archetype and Landscape

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ABSTRACT:

Today, designers must study and understand the culture of a place. In a “globalizing” world where standardization often rules with unfortunate consequences, it is imperative that professionals have strategies for understanding values and rituals of people, including their traditional ways of building community. Qualitative methods and grounded theory were used to interpret the human and historic landscape dimension of settlements in the United States and Africa.

The origin, evolution, and destiny of African-American settlements in the United States began as a precursory, multi-disciplinary dialog with the American landscape. Since the original hypothesis centered on socio-cultural and eco-physical factors influencing communities where inhabitants were “emancipated” to determine their destiny, slave villages were not extensively documented. The research was aimed at determining how African Americans had contributed to the built environment. Early communities did not adhere to traditional Western designs or to African building practices but were impacted by racial separatism and belief in ethnic superiority. As a result, African American structures and settlements were largely vernacular in nature, eclectic in style, and driven by the socio-economic, political, and physical context of the region.

Attention turned to African landscapes in order to understand the juxtaposition between African and western cultural archetypes. While the natural environment supports a diverse lifestyle, many aspects of the urban landscape are in flux and incongruent, depending on the tribes, customs, and environmental conditions. Unplanned settlements, with their incompatible environmental practices, co-exist adjacent to newly developed land uses.

Four theorems emerged from observation in Africa over a series of extended field visits dealing with layering of privacy, material use, relationship between developmental practices and belief systems, and cultural erosion related to the evolution of settlement and socialization. Observing and thinking critically about how culture is revealed and illuminated could aid in developing design strategies that would richly reflect tradition as the African landscape narrative expands.

ON MEASUREMENT: Integrating the human dimension in architectural research

KEYWORDS: Human dimension, socio-cultural landscapes, lessons



Figure 1: Farmland near Kampala, Uganda. Photographer: LBJWigfall

I. INTRODUCTION

I.1 BLACK SETTLEMENTS IN AMERICA

Too frequently, planners, architects, and preservationists assume that the past is pristine and linear, that places reflect only one kind of inhabitant, family, user, owner, purpose, or significance. For two hundred years, classical historical figures and resources were assumed to be the only important components of the American heritage. Researchers had a tendency to identify that heritage with Euro-American history, forgetting that America is an African as well as European “invention.” This attitude led to the investigation of black settlements in the United States as a response to Professor J.B. Jackson’s inquiry about contributors to the American landscape at Harvard University. Professor Jackson was a noted landscape critic and author who was fascinated with the American vernacular. He challenged students to expand the dialog about socio-cultural influences on the vernacular landscape. Initially, the investigation focused on the role of African-Americans in the development of the built American landscape between 1865 and 1920. Very limited information (written or oral) existed in mainstream publications about the accomplishments of the Negro following Emancipation. Generally, history recorded the life of pivotal statesmen, inventors, pioneers, and rebels, such as Booker T. Washington, George Washington Carver, Pap Singleton, or Harriett Tubman. In general, people acknowledge and accept these jewels through the National Park Service designations but what about the community builders and architects of cultural places? Surely, there were individual “Negro” men, women, families, and whole communities that transcended the atrocities following Emancipation and challenges of national building. In addition to these obvious omissions, how did African Americans migrate to urban enclaves? Historical sources, like Nell Irvin Painter, referenced the great exodus from the South in 1879 to Kansas, but what about other settlements? As primary and secondary sources revealed over 800 communities had existed during this pivotal period in US history, the research expanded to include the identification, documentation and interpretation of neighborhoods, suburbs, towns, villages, and settlements across the United States. The national planning and design study intended to document black settlements as a dynamic entity. The research addressed the origin, evolution, and destiny of the communities in order to expose black settlements as a significant national phenomenon and to demonstrate the importance of historic and cultural resources. A more extensive study later investigated the regional planning dynamics of economics, socio-cultural, political, and physical elements in the survival of black communities. National Archives and Library of Congress records provided the most comprehensive overview of community development and helped establish a settlement typology for later evaluation. Oral history recordings and informants, usually community elders, confirmed and expanded the database. Cartographic, photographic, and geographic records supported information gleaned from census data, oral informants, and field studies.

Since the “Black Settlements in America” precursory research began, the database has been utilized for numerous preservation projects throughout the United States in an effort to empower African-American communities. Although these strategies for future development have been linked to cultural resources and traditions in this country, there was still great curiosity about the predecessors of slave communities and social structures that may have influenced certain patterns on the colonial landscape. Investigating the relationships between culture and the African landscape (especially Senegal where slave trading was most pronounced); ethnography and architecture; and lifestyle and environment was a logical step towards that understanding.

I.2 PATTERN IN THE AFRICAN ENVIRONMENT

Since the original hypothesis centered on the socio-cultural and eco-physical factors influencing communities where inhabitants were “emancipated” to determine their destiny, very little attention was given to environments occupied by slaves or free men prior to 1862. As the earliest research uncovered primarily contraband camps, rural villages, and unincorporated towns, it was clear that these early communities did not adhere to traditional Western designs or to African building practices, which were discouraged by whites. After deeper investigation of early slave communities, it was clear that some cultural influences had directed the order and organization of these settlements. Several material culture historians had drawn connections between the design of southern slave

cabins and shotgun houses in both rural and urban settings. But was that all that exists? What about community/town planning principles and governance? How does the African landscape narrative inform African-American community development in the United States? Expanding the investigation by exploring African antecedents of the colonial period was a natural progression, enriching the original work by the new knowledge and a fresh perspective obtained only through additional field observation. Attention turned to West Africa, specifically Senegal and The Gambia, due to the prolific slave trafficking by the French and English from Goree Island. The following project objectives summarized early interests: 1. to advance the original research by exploring the antecedents of slave villages in West Africa (document settlement patterns, community organization, and land uses); 2. to identify Afro-centric patterns and socio-cultural influences reinscribed and interpreted in the Senegalese environment; 3. to observe trends and differences in landscape architecture in Senegal and the socio-political factors that shape it; 4. to juxtapose architectural design in Western culture and Senegal; 5. to expose students and the public-at-large to Senegalese culture through lectures, educational posters, and course content. (The posters would depict historic and contemporary environmental patterns, “genealogy of the land”, and aspects of community life.); 6. to assess the validity of the current research methodology in collaboration with Senegalese scholars documenting their village histories and folklore.

Although understanding the historical evolution of the landscape was most important to historic documentation, preservation, and tourism, as had proven valuable in the study of the American landscape, finding those antecedents would also inform future planning and design of communities in the United States as well as Africa where historic resources were being depleted by modern development without regard to cultural roots. Knowing how socio-cultural practices influence the built environment, and how pattern, whether land-related, behavioral, or culture-based, explains where, how, and why people live in certain circumstances became the focus of the first field studies in Senegal. Although a great deal of the Senegalese physical fabric was obscure and difficult to identify due to the influence of the ruling class, seeing and documenting the landscape firsthand was both an insightful and personally spiritual (emotional) experience.

Observations and photo-documentation in Senegambia provided the first theories about the patterns in the African landscape. Four theorems, focusing on material use, layers of privacy, development practices, and settlement patterns related to cultural erosion, emerged for testing with subsequent trips to West Africa and Uganda/Kenya over the next four years. Another extended observation as a Fulbright Scholar in Tanzania validated the premise behind the theorems and provided extensive examples in East Africa. Student projects in unplanned “urban” settlements revealed contemporary land use issues for later consideration.

2. BLACK SETTLEMENTS IN AMERICA

2.1 PREMISE AND DISCOVERY

Without question, human history is layered, intermeshed, fused, and even confused. As people migrated from continent to continent, and from rural to urban environments, they left remnants of their lifestyle for posterity. If historians, planners, and designers examine “the geology of the land” they can begin to understand this complex web of associations, uses, and physical manifestations. Only the land can offer an accumulative history of composite efforts. Research in an untraditional area such as vernacular or black material culture reveals that, in reality, extracting the chronology of African-Americans from this fabric is difficult because a great deal of their contributions were ignored or not cultivated. In most cases, there is more to be learned than appears on the surface. The passing of time is a key factor in the lesson. Designers understand that a building has a “skin”, or outer covering, which weathers or is altered over time. A building also has internal members and multiple additions that can reveal something about past lifestyles or attitudes. This same principle may be applied to landscapes but we must constantly remind ourselves that surface clues will be subtler, or even obscure, in the land-related resources than with architecture.

There were African-American settlements thriving in the West before Pap Singleton and the “exodusters” began their trek from southern oppression to the promised 20 acres and a mule in the

West. By the late 1800, migration of people of color in this country was a common phenomenon. This movement had begun prior to the dark slavery era. Africans came to the North American continent, specifically Canada, with the French, Irish, and other Europeans, settling peaceably in the Bay of Fundi as early as 1691. No doubt many of these settlers to the New World travelled with their North American neighbors, primarily Native Americans, across the border into America. Other people of color migrated across the Atlantic to the West Indies, but the majority of them came under slave trade to the southern states and remained in captivity until their death.

Much has been written about the slavery years – elaborate descriptions of the economic, socio-cultural plight of proud Africans transported into demoralizing conditions. Historians have portrayed this period of history as glorious for America while describing only the limited contributions that African-Americans made in their newly found homeland. Few historians offer other accomplishments made by them except: the economic benefits the southern majority derived from their “Negro” field hands’ and servants’ labor; and the contributions of individual, exceptional “Negro” leaders.

Collectively, African-Americans built their slave communities, established rural settlements and towns, and sustained urban enclaves despite potential perils from their southern owners or the weather. It is between 1865 and 1920, when African-Americans were free to establish their economic, political, socio-cultural, and physical manifestations, that we find the most prolific development of the race.

2 AFRICAN-AMERICAN SETTLEMENT TYPOLOGY

Prior to the Civil War, *slave villages* thrived as self-sufficient units on the landscape, producing the nation’s largest commerce – cotton. No plantation was organized the same. Most homesteads were segregated according to white owners and foremen, Negro house servants, and Negro field hands. In the south’s peak production period, plantations were strewn along the Mississippi River in clusters. The “big house” was usually located on higher ground, thus reducing the probability of flood damage. These family mansions were the epitome of glorious, southern lifestyle, contrasted by the humble frame or occasional brick one-room units (which had to be rebuilt independent of their day’s regiment with each overflow of the river) on the other side of the railroad track. Perhaps, the plantation stigma of living “on the other side of the tracks” followed Negroes to their American cities long after slavery. This notion about the land and how people live on the land is pervasive in the structure of our landscape today—large lots with expansive setbacks and dominant residences vs. dense cottages abutting the public easement with little opportunity for privacy.

Most slave cottages were arranged in a gridiron pattern in order to monitor the activities of slaves. Seemingly slaves built identical units, equal distance apart in long rows. When slaves had the freedom to select their settlement sites, cottages were scattered among the bottomlands in an attempt to both secure their settlements from the foremen and also from harsh environmental conditions. Most plantation foremen did not like the latter settlement pattern because it perpetuated successful escapes. Typically, cottages were built on grade with dirt floors and were subject to constant sweeping to reduce the dust. (This is a pattern found in urban African communities today.) In more affluent villages, units were built above-grade; in high water table conditions, even brick units. In any case, slaves attempted to arrange their units in ecologically stable areas, taking advantage of sun angles for appropriate shade, wind for cross-ventilation, and water run-off.

While the South battled for its precious right to retain servants as slaves, *contraband camps* were established as temporary living quarters for the protection and administration of Negroes fleeing that way of life. Freedom came early to Negroes in the North; President Lincoln’s proclamation in 1862 resulted in a great underground migration to northern cities prior to the close of the Civil War. For instance, over 10,000 Negroes flocked to forts, like Freedmen’s Village (near Arlington National Cemetery) that surrounded Washington, DC. By 1883, Village residents were forced to disband, founding new villages, such as Penn Rose, Halls Hill, and Queen City (The Pentagon). After 1865, *freedmen villages* continued as farm units, fostering pride in individual productivity.

Most freedmen did not travel long distances to the north; the majority of them found a safe haven with Union troops confiscating properties during the War. Many were considered contraband. Upon the close of the Civil War, Negroes with any articles or animals could register with the Bureau

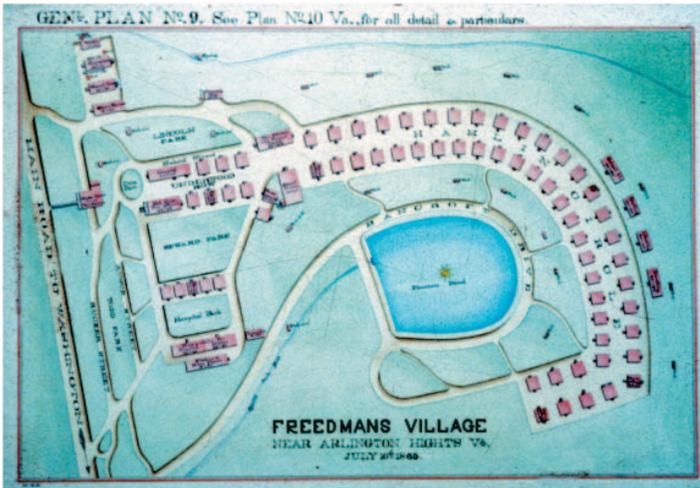


Figure 2: Freedmans Village, at Arlington National Cemetery, was an unusual semi-circular development pattern built by slaves with varied farm lots along a secondary road system forming sub-communities. (National Archives, Quartermaster General Records)

and request relocation. The Bureau provided protection to travelling freedmen, land for settlement, and in some cases, animals and tools; and distribution of food and clothing. Many freedmen filed as family units, settling in clusters in a natural along the Mississippi River, in order to share equipment and farm responsibilities as well as defend against raids. They worked plots of adjoining land cooperatively, maintaining deep local identity and organization not obvious to outsiders. (These communities had names known by the residents but most were never recorded because of size and/or census taker fear of discovery.)

Frustrated with Reconstruction efforts, many Americans saw self-government and improvement as the only salvation for the Negro. *Rural villages* proliferated from Virginia to California, and Florida to Washington. Trained ex-slaves, left to run the plantation while the owner defended the Union during the Civil War, established many of these settlements. For instance, Isaiah T. Montgomery successfully managed Jefferson Davis's cotton production and commerce in town but after the War, Joseph Davis redeemed the family honor and property, leaving Montgomery to migrate north and found Mound Bayou, Mississippi. Isaiah and his brother were not the only African-American community developers in the western territory. Others like Zach Fletcher, Ben Carr, S.P. Roundtree took advantage of the Townsite Preemption Act to establish town companies, promoting their settlements in the south, and escorting families to their free government lands. Nicodemus, Kansas is one of the typical western townsites established using similar speculation methods, like Benjamin "Pap" Singleton Tennessee Real Estate and Homestead Association's development activities.

The *Black Town* was the ultimate governing institution, offering self-determination for Negroes. Between 1880 and 1920, black towns proliferated and flourished in the South and West. Incorporated political bodies were founded to perform various functions, such as railroad towns (Mound Bayou, Mississippi or Kendleton, Texas); industrial towns (Buxton, Iowa); college towns (Prairie View, Texas); resort towns (Lincoln Hills, Colorado); market towns (Boley, Oklahoma); and migratory towns (Allensworth, California).

As part of the New Deal programs, the government attempted to relocate marginal farmers onto government farmsteads. This *rural resettlement* strategy was not necessarily targeted at African-American farmers; on the other hand, successful settlements were established using their labor. Most of the units were designed in regional offices and built by the farmers on location; therefore, the builders adapted units according to environmental circumstances.

Urban Enclaves were fragments of black settlements that flourished beyond the city limits and were consumed by urban growth. These enclaves were segregated pockets of African-American families within or near the city. After slavery, a number of freedmen migrated to urban environments for services and employment, but the majority remained on work farms in the South. With railroad expansion in the south, Negroes cut routes through thick swamps, fought to move Indians west, and helped establish railroad towns. For example, Negro railroad men comprised more than 44% of the incorporators needed to establish the City of Miami, Florida; once founded, they were disenfranchised. As cities grew, the “enclave” represented an unwanted pocket of low-income citizens at the city’s core. The value of downtown property made it increasingly advantageous to redevelop those areas. Urban renewal schemes eventually destroyed many of the enclaves, leaving a handful of isolated structures among high-rise development.

Alley Dwellings were a specific type of urban enclave, established in the late 1860, as carriage houses and frame shacks developed for the enormous Negro population influx from the South. In some cities like Washington, DC with superblocks, the redevelopment of these large neighborhoods was administered by the Alley Dwelling Authority that realized too late that the availability of replacement housing was essential in reclaiming the alley dwellings. Thus, the DC Housing Authority was created to oversee the early form on urban renewal. Ironically, the nation experienced a similar phenomenon by the Authority’s predecessor – The Department of Housing and Urban Development—during the 1960s.

3. PATTERN IN THE AFRICAN ENVIRONMENT

As a result of several trips to West Africa, four theorems of African archetypes developed for further testing as travel permitted to East Africa (specifically Uganda, Kenya, and Tanzania), South Africa, and Botswana. Data collected in the field is analyzed using grounded theory to establish the theorems. Key elements are marked with a series of conditions and circumstances, which are extracted from the field observation. The conditions are grouped into similar concepts, for instance, construction habits, lifestyle or patterns of living, and environmental patterns, in order to make them workable. Framing the field data was based upon the application of building materials, observation of spatial relationships, understanding of cultural practices, and documentation of colonial settlements and villages. These concepts are the basis for the creation of the four theorems, or hypotheses. Developing metaphors for each concept made them more comprehensible and, in some cases, palatable. Later, sharing the observations with African architects in Senegal, Kenya and Tanzania, and African-American architects in the United States were designed to test the four theories and glean feedback.

3.1 JOURNEY IN TIME, PLACE, AND CULTURE

Four theorems emerged from observation in Africa dealing with layering of privacy, material use, relationship between developmental practices and belief systems, and cultural erosion related to the evolution of settlement and socialization. *Life is Circular*, an African Proverb, addresses how natural materials retrieved from the ocean are temporarily utilized in construction as architectural detail, road aggregate, and/or concrete mix but eventually deteriorate and are returned to natural origins. *Over The Wall* addresses layers of privacy and distinct customs that grew out of shared rituals and values at a cultural crossroads. The courtyard house provides a private, protected outdoor space where women of an extended family can meet and work, and children can play. The Process of Becoming speaks to the intrinsic relationship between “piecemeal” construction and the belief that all of life is striving to reach higher levels of awareness. This self-knowing process happens over time with great patience and deliberateness just as construction of a habitat occurs. *Trash in/Treasure out* explores the cultural erosion that occurred due to colonialism.

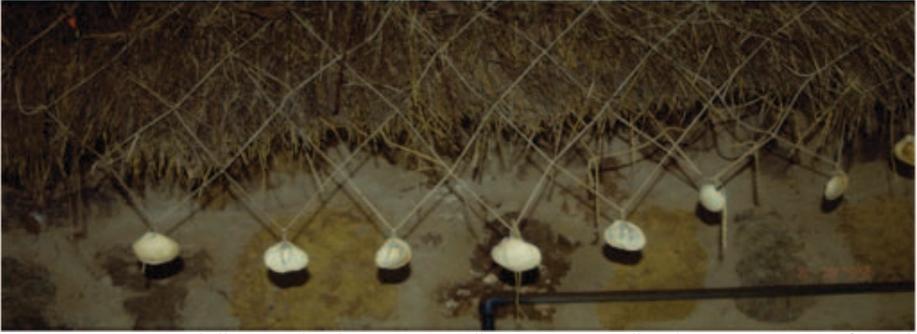


Figure 3: Sea or cowry shells are used as decoration on walls, as accents or wall/curb trims, as aggregate for roads and buildings, and as fabric patterns. Photographer: LBJWigfall

3.1.1 Life is circular

“Life is circular” is an African proverb usually spoken in West African cultures. Africans, like most people of color in history, utilize every aspect of their environment, especially the natural elements around them. Historically, seashells were the medium of exchange in pre-colonial Africa, Indian and Pacific Islands, Caribbean, and North America. As Western European explorers settled the continent, indigenous cultures were eroded by cultural imperialism. Alternative forms of money superseded the “cowry” shell, the most common species of shells used as currency. Throughout the centuries, cowry shells have been utilized in numerous ways – tools, bulk source of calcium in horticulture, components of musical instruments, ritual objects, religious symbols, personal adornment, arts and crafts, and/or architectural decoration – due to their strength and variety of shapes. Seashells are crushed and mixed in the soil for farming nutrients and/or aggregate for road surfaces, paving, concrete, or wall surfaces. Shells are hung from eaves, door openings, and/or walls as decoration. They are embedded in curbs, sidewalks, sills, baseboards, moldings, cornices, fireplaces, and floor surfaces to enhance the texture, color, and visual interest of elements. Even fabric for women’s clothing is adorned with large shell print patterns in traditional East African settings. Using the seashell as the metaphor for the proverb, the shell is photo-documented from the sea, depositing on the beach, through various uses in African culture until it disintegrates and returns to the sea with high tides. This circular process of natural materials is particularly prevalent in Senegal and indigenous cultures influenced by England and France. “Life is Circular” demonstrates how cultural philosophy and environmental design coincide.

3.1.2 Over the wall

The wall is a very important component of the village and habitat, defining these levels of privacy and space. Although there were boundary walls and fences to mark villages and neighborhoods, the theoretical construct—“Over The Wall”—was based upon urban walls that either defined the public-private realm or neighboring properties. Because the street is densely populated with pedestrians and cars, the design of walls is critical to the owner and to the public. Height and thickness of walls vary according to the function of the wall and the combination of natural and manmade materials in response to the function. Family or community activities, depending on the nature of the wall, occur behind the wall, protecting personal interaction and belongings from sight. Walls are usually too tall to see over and thick enough to muffle sound from the street. Passing through the opening in the wall leads to an open court in middle class houses trimmed with small planting as noise buffers on the street side, a small tree or African pavilion for shade, and/or a colonnade to interior spaces. Less fortunate, inner city compounds are usually filled with washboards, clotheslines, well or water pump, goats and small animals, and miscellaneous household utilities. Both spaces are well swept each morning to remove debris, insects, and excess dirt. Children play in this outer space protected from public scrutiny by the wall. Beyond the larger court is often a smaller, more intimate space before the front door. This space may be separated from the previous court by a level change,



Figures 4 and 5: Natural and Manmade walls separate street activities and provide the first layer of privacy for families. Walls, which define the compound in rural settings, are used to protect and screen the family, regardless of socio-economic status. Photographer: LBJWigfall

upright plant material or another wall and gateway, but minimally a material change, usually tile, in affluent residences. This division of space before entering the house establishes public-private spatial sequence, layers of privacy, and noise reduction into the house. Visitors to the house find similar layers of space within the living unit—a parlor or receiving room meant to act as the interior court, screening private, lower level rooms from houseguests. These rooms may function as extended family bedrooms, small family gathering spaces similar to a den, and/or a kitchen, and generally have connection to another courtyard or rear, very private exterior space. These lower spaces have strong adjacent relationships with the outside although their interiors are not obvious and rarely seen except an occasional glance when beads or fabric door coverings are parted. The second floor, separated by a grand staircase, houses the social and living spaces, usually larger and more formal configurations for entertaining personal guests. This part of the house and floors above have very high ceilings as well and appear very lavish with gold detailing, various tiles, and lighting. Even the most modest urban homes exhibit some of these characteristics, exemplifying the importance of levels of privacy in society, marked by the wall.

3.1.3 The Process of Becoming

Many Africans are Muslim by faith, adhering to the Six Articles of Faith. Muslims also have beliefs about life, salvation, and afterlife. For a Muslim, the purpose of life is to live in a way that is pleasing to Allah so that one may gain Paradise. Like Christianity, Islam teaches the continued existence of the soul and a transformed physical existence after death. This conscious intention to perform good works for salvation and strive to achieve a higher level of spiritual existence can be summarized as a “process of becoming”. Observation of the indigenous construction environment suggest a similar attitude, one of building “the temple”, in this case, the home, in piecemeal. At first glance, the community, cluttered with piles of sand in the street for making brick and miscellaneous building materials stored on every lot, appears in disarray, as if devastation has occurred. Destruction seems immanent. This perception proved quite contrary to the actual undertaking. Inquiry yielded an individual building process based upon the availability of funds to proceed. Most residents in urban neighborhoods explained the process of homeownership depended upon the owner to participate in cooperative building practices, laying as few as one row of bricks when affordable. This construction pattern is distinctly different from western or corporate practices to secure the majority of the funding prior to building in order to substantively complete the project. In the former case, the society accepts and supports piecemeal building practices in the same way it understands and encourages individual striving in life towards a pleasing outcome, paradise. This “process of becoming” in Muslim belief exemplifies the patience in sacrifice and submission to the environmental circumstances of building another temple—the home—an important tenet of their faith.

3.1.4 Trash In/Treasure Out

This controversial theorem explores the cultural erosion that occurred in African settlement due to colonialism. As Western Europe invaded and colonized the African continent, certain distinct, indigenous customs and beliefs were superseded. This eroding of African culture can be metaphorically compared to the effect of the sea along the African shore and the derogatory use of “White Trash” to refer to a class of whites in the United States. Historically, settlements were established along the Africa coastline, avoiding penetration inland and hostile tribes without native guides. The deposit of manmade debris along the shore represents this invasion today. As the tide recedes, shoreline is eroded in the same manner, slave traders confiscated Africans as workforce in the Americas. Before natural resources, such as minerals, diamonds, animals and habitat, were extracted from the Continent, native people were its treasure. Today, this erosion process, like the effect of the sea, continues in the flow of labor, culture, art and artifacts, fabric/fashion, and style primarily to Europe and the Americas. Slowly, what culture remains is minimized and replaced by western development ideas, thus, cultural erosion. Evidence of corporatocracy thrives in most developing African cities, partially because of the comparative investment in the economy made by these companies and proliferation of their urban design standard. Ultimately, these cultural differences and architectural nuances will have a profound impact on the African landscape, as urban expansion continues to encroach upon rural development.

4. CONCUSION/PARTING THOUGHTS

History is not complete until we have a thorough accounting and understanding of all of the formative forces that shaped the landscape narrative of a place. Expanding the process of observation and review beyond the standard boundaries leads to key insights and new sources for consideration. This broader approach, watchful for typical behavioral and/or landscape patterns, does not assure a higher-quality interpretation but it offers a greater number of identified resources and documented layers of history. Utilizing qualitative methods, grounded theory, and comparative analysis techniques, the final stage of interpretation will more appropriately define the essence of the resource. The synthesis of complex and subtle layers of documentation and the use of metaphor can offer a more palatable, and often comprehensive, landscape theory.

Despite all that has been revealed, this investigation of black settlements and African patterns in the landscape has generated more inquiry and question. How is environmental practice transferred and manifested? Further study about village and compound design should further explain the systematic order of slave settlements but the larger question will require more rigor and discipline. Exploring the historical construct of the African landscape has become only a small component of the evolving research goals. Just as exemplified in the original study, it is imperative that any study also focus on current trends and differences juxtaposed against western philosophies of design. Understanding how culture is revealed and illuminated on the African landscape aids in developing strategies that will richly reflect its tradition and culture as the country grows. A multidisciplinary approach, soliciting other African scholars with in-depth knowledge of everyday situations, goals, attitudes, and values, is imperative. Consequently, understanding historical cultural landscapes, whether in the Americas or Africa, will not only generate a healthy curiosity and appreciation about our collective history but also underscore the significance of documenting and re-examining our threatened resources. Too often, lack of knowledge and exposure shapes the designer’s responsibility to create more efficient and contextual spaces for people. Although history has come full circle, we stand in this timeless place for one brief moment. Let it be a transforming experience, not a disservice to our great heritage.



Figure 6: Entrance to Slave House on Goree Island, Senegal, West Africa. Photographer: LBJWigfall

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ENDNOTES

African-American (also referred to as Black American or Afro-American)—residents of the United States who have at least partial African ancestry. Most African-Americans are the direct descendants of captive Africans who survived the slavery era within the boundaries of the present United States, although some are—or are descended from—immigrants from African, Caribbean, Central American or South American nations.

Black—a racial classification of humans, usually people with all possible kinds of skin pigmentation from the darkest through to the very lightest skin colors, including albinos. It is also used to categorize a number of diverse populations together based on historical and pre-historical ancestral descent. (Reference: descendants of the Black Africans who were enslaved and shipped to the Americas by way of the Atlantic slave trade). Among the members of this group, dark skin is most often accompanied by the expression of natural afro-hair texture. The term black was used throughout but not frequently as it carried a certain stigma. With the successes of the civil rights movement a new term was needed to break from the past and help shed the reminders of legalized discrimination. In place of Negro, black was promoted as standing for racial pride, militancy and power.

Negro—used in the English-speaking world to refer to a person of black ancestry or appearance, whether of Africa descent or not, prior to the shift in the lexicon of American and worldwide classification of race and ethnicity in the late 1960s. Negro superseded “colored” as the most polite terminology, at a time when “black” was more offensive. The term “Negro” is now widely considered to be obsolete and it is not commonly used. It is still used in some historical contexts. Modern language uses: Black; additionally, Black African for people native to the African continent, and African American for people in U.S.A.

Exodusters—African Americans who fled the Southern United States for Kansas in 1879 and 1880. After the end of Reconstruction, racial oppression and rumors of the reinstatement of slavery led many freedmen to seek a new place to live. Many migrated to, and then settled, primarily in Kansas because of its more progressive and tolerant reputation. Of note however, western migration of African-Americans was not limited to the Exoduster period, and places like Nicodemus, Kansas thrived for some period before, during, and after the Exoduster movement. Similarly, in following years (although not part of the original Exoduster movement of the 19th century) in the early 20th century black migrations to the American West and Southwest—generally known as the Old West -- would continue, and several additional all-black towns would be established, especially in Indian Territory, which was to become the current state of Oklahoma.

Muslim—The word Islam means ‘submission to God’ and an adherent of Islam is called a Muslim. For a Muslim, the purpose of life is to live in a way that is pleasing to Allah so that one may gain Paradise. Like Christianity, Islam teaches the continued existence of the soul and a transformed physical existence after death.

White Trash—an American English pejorative term referring to poor white people in the United States, suggesting lower social class and degraded living standards. The term suggests outcasts from respectable society living on the fringes of the social order who are seen as dangerous because they may be criminal, unpredictable, and without respect for authority whether it be political, legal, or moral. It is used among blacks as an attack against whites. Use of “white trash” epithets has been extensively reported in the African American culture. Black authors have noted that blacks when taunted by whites as “niggers” taunted back, calling them “white trash.” and black parents taught their children that poor whites were “white trash”. The epithet appears in black folklore, as when slaves (when out of earshot) would refer to harsh overseers as a “low down” man, “lower than poor white trash,” “a brute really.”

Impact of different weather data sets on photovoltaic system performance evaluation

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ABSTRACT:

Building energy simulation plays an important role in decision makings involving energy conservation measures and choices of renewable energy systems in building designs. Traditional simulation tools rely on weather data sets called Typical Meteorological Year (TMY), representing a typical year of weather at ground weather stations throughout the United States. These data sets are constructed using an algorithm to select the “most typical” month of the many years in the database for each month. Some recent publications suggest that one-year TMY data is no longer sufficient to evaluate long-term performance of PV systems, because a typical year does not taken into account extreme weather, and thus does not address the meteorological uncertainty that might occur. Actual electricity outputs from photovoltaic systems vary from year to year. Having more accurate information about production performance should help facilitate system selections that match building designs and how to operate them. In this study, four sets of weather data, Detroit TMY2, Ann Arbor TMY3, Ann Arbor 15-year NSRDB, and Ann Arbor 13-year SolarAnywhere®, are used as inputs in PV system performance simulation. Their impacts on the PV system electricity output availability, variability and uncertainty are analyzed and compared. The magnitude and consequences of the analyses of different weather data sets are presented.

CONFERENCE THEME: On Measurement: What is performance? Approaches to energy, occupation, consumption and reuse.

KEYWORDS: Weather data, photovoltaic system output, availability, variability, uncertainty

INTRODUCTION

The performance of a building is a result of complex processes. A better building design can reduce energy use by 30% compared to a conventional building design, while still provide an equal or better environment for its occupants. To reach a 50% reduction or more, renewable energy system integration is needed (USGBC Research Committee, 2008). Barriers to achieve this goal is usually not technology constraints, but poor data to make informed decisions (Clarke, 2001). Building simulation tools are created to help provide real world replication and predict how buildings and systems will perform once they are constructed and implemented, thus providing information for decision making. Building energy performance prediction tools are a series of complex mathematical models that address the dynamic interaction of building and system performances with building geometry, plan, components, system choices, climate conditions and occupant use patterns. These computer based simulation tools usually require local weather data as main inputs for outside conditions. Performance simulation of solar energy systems such as a photovoltaic (PV) system relies heavily on specific time-location hourly weather data.

The availability of solar radiation at a specific site varies according to location latitude, topography, time of day, time of year, cloud cover and atmospheric aerosol condition. The amount of solar radiation and its temporal distribution at a specific location are essential information for determining if a PV system is suitable for that site. This information can be used to select the solar energy system's size and predict its performance and operation. Onsite measured solar radiation provides the most accurate information. However, measurement equipment and their maintenance are costly. Solar radiation data can also be obtained from the nearest ground weather stations which monitor weather data such as daylight hours, air temperature, humidity, pressure, wind direction, wind speed and other climate-related information. Protocols such as the International Daylight Measure Program (IDMP) have been developed as a guideline for these meteorological data measurements (CIE TC 3-07, 1994).

IDMP also provides quality assurance procedures so that data from weather stations following this protocol can be compared and utilized uniformly. The National Solar Radiation Data Base (NSRDB) maintains hourly weather data sets at various weather stations throughout the country from 1961-2005. To accommodate building simulations utilizing weather data, one-year Typical Meteorological Year (TMY) weather data sets are developed from information in the NSRDB database. TMY is an hourly weather data set that is usually used in building simulation tools. It represents a “typical year” of weather for ground weather stations. Results from simulation using TMY weather data sets will represent building performance in “typical weather.” Recent publications suggest that using one-year TMY data for PV performance evaluations might not be suitable (Storck et al., 2010, Dean, 2010), because a typical year weather data set omission of extreme weather leads to the inability to predict atypical weather that might occur.

At locations away from ground weather stations, data from the nearest station or, alternatively, estimates based on the interpolation of data between stations are used. The problem with using data generated in this way is that the accuracy of the data decreases with distance from or between ground weather stations. A method to estimate solar radiation based on data from meteorological satellites has been developed. An example is the State University of New York at Albany (SUNYA) model developed by Perez et al. (Perez et al., 2002). In the SUNYA model, satellite images are used to derive solar radiation data that is time and place specific. These satellites are geostationary, staying fixed over one spot directly above the equator to monitor the earth’s atmosphere. The geostationary satellite data offer the advantages of wider geographic coverage with high-resolution images typically at one to ten square kilometers per pixel. They repeatedly scan earth’s image, typically at 30 to 60 minute intervals. Mathematical models are developed to generate high-resolution solar radiation resource maps based on this data.

This study compares results from PV performance simulation using different weather data sets. Within these data sets, ambient temperature, global horizontal irradiance (GHI), direct normal irradiance (DNI) and wind speed are the most importance parameters. A building located in the northern part of Ann Arbor, Michigan was used to provide context for this experiment. PV outputs generated from satellite-derived weather data set were used in comparison to the outputs from three other weather data sets. Their impacts on the PV system output availability, variability and uncertainty were quantified. The availability of PV output is how much electricity is expected to be generated from the system in one year. Electricity output variability was obtained by calculating the daily average standard deviation of each month. A histogram was used to quantify the frequency of the daily electricity output to show the uncertainty that might occur.

I. BACKGROUND

I.1 NATIONAL SOLAR RADIATION DATABASE (NSRDB) WEATHER DATA

Solar radiation data in the United States are available from the NSRDB. The database is developed by the National Renewable Energy Laboratory (NREL) and the National Climatic Data Center (NCDC), and provides hourly solar irradiance and other climate parameters for public use. Data from 1961 to 1990 are available for 239 locations, and data from 1990 to 2005 are available for 1,454 locations (Figure 1). Among these locations, only 40 stations have solar radiation measurements. At other locations, solar radiation data are estimated using calculations based on other weather parameters measured at ground weather stations such as barometric pressure and the amount of cloud cover. Several solar radiation calculation models have been developed to predict the available solar radiation at ground weather stations without solar radiation measurement equipment such as the METSTAT model which was developed for the NSRDB (Maxwell, 1998). The available solar radiation measurements from 40 stations are used to validate these solar radiation models.

I.2 TYPICAL METEOROLOGICAL YEAR (TMY)

Weather data at each location show variation from year to year. To obtain average building performance from a simulation, several years of weather data should be used. However, using several years of weather data is time consuming. Therefore, a Typical Meteorological Year (TMY) is

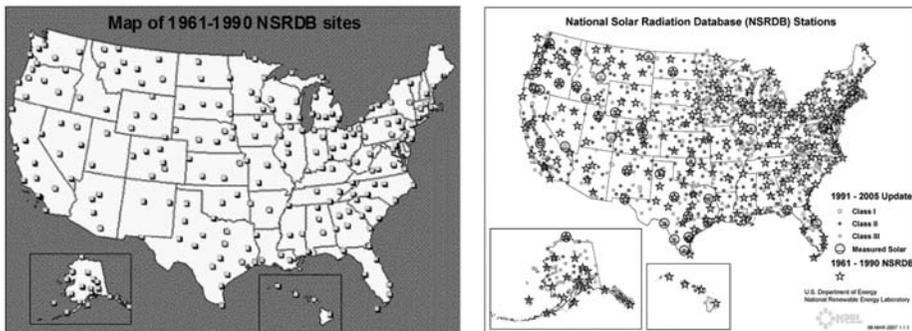


Figure 1: NSRDB sites (source: NREL)

developed and normally used as a representative of weather conditions at that location in building simulation programs. TMY is composed of hourly weather data such as temperature, humidity, solar radiation, wind speed and wind direction for 12 months. Each month was selected from multi-year database using statistical methods, with the condition that it represents the most typical weather pattern of that month. TMY2 (Typical Meteorological Year version 2) provided from the NSRDB is generated from 30 years of data from 1961 to 1990 and available for 239 locations in the United States. Statistical methods were used to select the typical month based on nine daily weather values such as daily maximum, minimum, and mean dry bulb temperature, the maximum and mean wind velocity and the total global horizontal solar radiation. The latest data set called TMY3 (Typical Meteorological Year version 3) contains weather information including solar radiation data at 1,454 ground weather stations throughout the country. Typical month weather data were selected from a 15-year database from 1991 to 2005.

Some simulation tools have embedded or built-in weather data that are derived from TMY2, for example, PVWATTS 1.0. When using these tools, the nearest available location in the tool is normally used to represent the site weather condition. TMY2 is not available for Ann Arbor. Therefore, Detroit TMY2 is always used to represent Ann Arbor typical weather. Some programs allow weather data inputs. In this case, TMY3 which is a newer version of TMY2 and is available for Ann Arbor can be used. However, the Ann Arbor TMY3 data are collected at Ann Arbor municipal airport which is located in the southern area of the city.

1.3 SOLARANYWHERE® SATELLITE-DERIVED WEATHER DATA

Recently, specific location weather data sets derived from satellite images have become available. Examples of satellite derived weather data are available from SolarAnywhere® (Clean Power Research, 2010) and 3Tier (3TIER Inc., 2010). Weather data sets derived from satellite images, for example, SolarAnywhere® data sets includes hourly global horizontal irradiance (GHI), direct normal irradiance (DNI), wind speed, and ambient temperature estimated for the specified location. These data from 1998-2007 are available for free. More recent data, as well as seven-day forecast data, are available for a fee. The spatial resolution of the data is available at approximately 10 km x 10 km in the form of satellite grid tiles (Figure 2). Real-time data like those from SolarAnywhere® provide an ability to obtain real-time PV system efficiency.

Solar radiation data generated by the traditional models METSTAT and NRCC, and solar radiation data generated by the satellite based model, SUNYA, were evaluated in 2005 by Myers et al. (Myers et al., 2005). The results show that the performance of these models was remarkably similar. However, when the distance between the site and the ground weather station is more than 34 kilometers, the solar radiation data derived from satellite images using algorithms like SUNYA are more accurate than using the nearest weather station data or the interpolation data between stations (Perez et al., 1997).

SolarAnywhere®

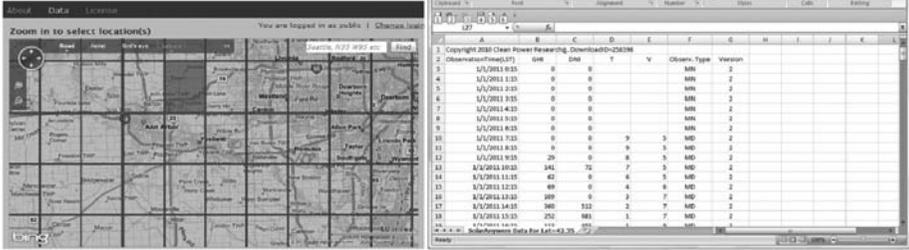


Figure 2: SolarAnywhere® data set grid tiles and outputs

1.4 SOLAR ADVISORY MODEL (SAM)

SAM is a program available free of charge from the National Renewable Energy Laboratory (NREL) (National Renewable Energy Laboratory, 2010). It is a standalone renewable energy system performance and economics simulation program. This tool was developed by the NREL in collaboration with Sandia National Laboratories and in partnership with the Solar Energy Technologies Program (SETP), U.S. Department of Energy. The full version was first available in 2006. For PV system performance, SAM can model a range of solar energy technologies including crystalline silicon (cSi), thin film (CdTe, CIGS and aSi) concentration photovoltaic (CPV), multijunction concentrator photovoltaic (mj-CPV), and heterojunction with an intrinsic thin layer (HIT). Within SAM, there are options of sub- simulation models to choose from (Figure 3). Plane of array (POA) solar radiation models available in SAM are isotropic sky, Hay and Davies, Reindl, Perez 1998 and Perez 1990. Array performance models, implemented using the TRNSYS program as a simulation engine, are the Sandia model, CEC performance model, simple efficiency model and concentrating PV model. The result from the array performance model is direct current (DC) electricity output produced from PV arrays. There are two inverter models available: the Sandia model and single-point efficiency model. The result from the inverter model simulation is alternate current (AC) electricity output that the inverter converted from DC output.

The models selected in this study are the Perez 1990 solar radiation model, the Sandia array model and Sandia inverter model. The Perez 1990 model is the update of the Perez 1988 model and is widely used in simulation programs to calculate solar irradiance falling onto surfaces. With the global horizontal and direct normal irradiance data from weather data sets, total solar irradiance falling on a tilted surface can be computed. The Perez model is well validated by many researchers

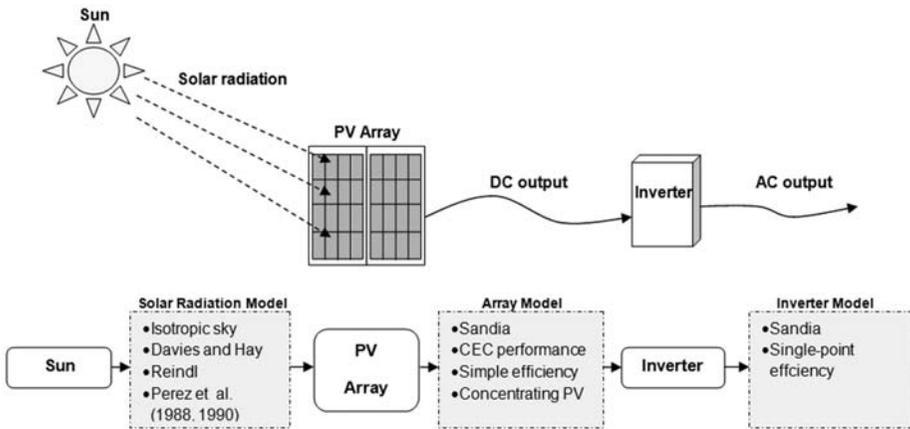


Figure 3: Diagram of mathematic models available in SAM

(Gueymard and Myers, 2009, Loutzenhiser et al., 2007). The Sandia PV Array performance model and the Sandia Inverter performance model use theoretical and semi-empirical methods. They utilize databases of empirically derived parameters developed by testing commercial PV modules and inverters in actual conditions. Validation of the models has been tested against measurement data and other models (Fannee et al., 2009). Figure 4 shows inputs needed for each model, their outputs and their relationships.

Weather data are needed in the solar radiation model and array model. Global horizontal irradiance and direct normal irradiance are used to compute the amount of total solar irradiance falling onto PV modules, while ambient temperature and wind speed are used to compute PV surface temperature, which will affect the amount of DC electricity output. Derate factors for the Sandia array model are efficiency reduction due to mismatch loss, wiring, diodes and connections, soiling, and module degradation. Derate factors for the Sandia inverter model are from the wiring and transformer.

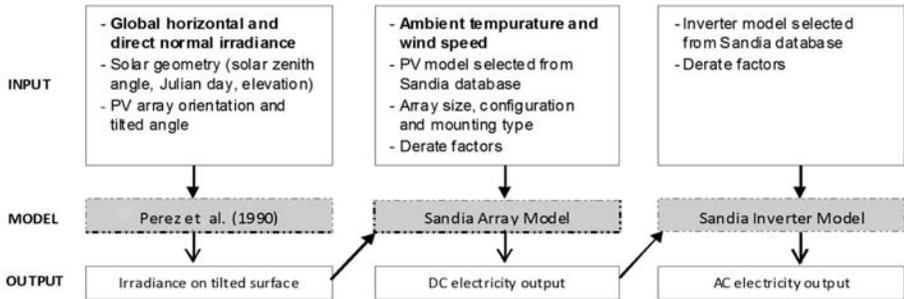


Figure 4: Inputs and output in PV system performance simulation

2.METHODS

An experimental study has been carried out to compare PV performance prediction using SAM as a simulation program and four different weather data sets for Ann Arbor, Michigan. These weather data sets are Detroit TMY2, Ann Arbor TMY3, Ann Arbor 15-year NSRDB (1991-2005) and Ann Arbor 13-year SolarAnywhere® (1998-2010).

2.1 PV OUTPUT PERFORMANCE PREDICTION VALIDATION

Uncertainties exist in every step of the calculations for obtaining a solar constant outside of the atmosphere, calculating the irradiance amount at the earth's surface, translating that amount into the irradiance falling on tilted surfaces, simulating how much DC electricity is generated from PV systems with available irradiance, and simulating how much AC electricity is converted from DC electricity output (Figure 5). In this study, a PV system installed on the roof of the Nature House at the Leslie Science and Nature Center (LSNC) was used as a validation system (Figure 6). LSNC is located in the northern area of Ann Arbor. SAM was used to simulate electricity output from the 2.5 kW DC First Solar Cadmium Telluride (CdTe) photovoltaic system. The DC electricity output was fed into SWR 2500U inverter. The simulation period was from May 2009 to April 2010 when the data of actual hourly PV output from the system was available for validation. The weather data set used in the simulation was SolarAnywhere® satellite derived weather data. The simulated PV electricity output from SAM compared to actual output shows only a 3% error rate. The root mean square error (RMSE) of the simulated output is 0.35 kW. Examples of PV simulated output compared to actual output are shown in Figure 6.

2.2 PV PERFORMANCE PREDICTION EXPERIMENT USING VARIOUS WEATHER DATA SETS

PV output prediction simulated using SAM and SolarAnywhere® was used as a base case to compare with three other weather data sets in terms of their availability, variability and uncertainty.

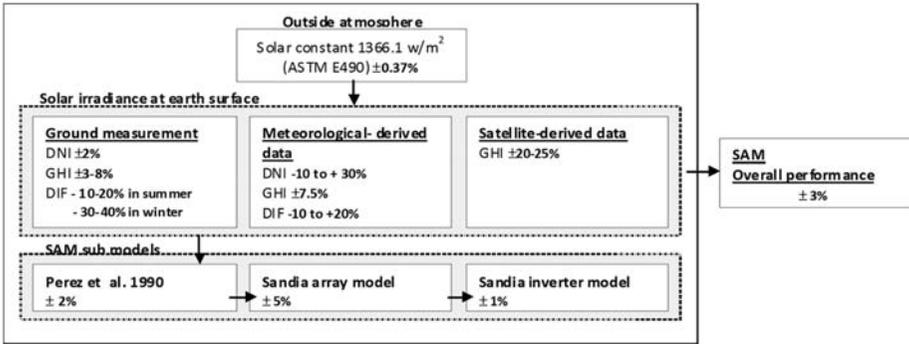


Figure 5: Uncertainties in each step of PV output calculations, solar constant (ASTM Standard, 2006), ground measurement (Gueymard and Myers, 2009), meteorological-derived data (Maxwell, 1998), satellite-derived data (Perez et al., 1997) and SAM sub-models (Cameron et al., 2008) were compared to overall performance in this study.

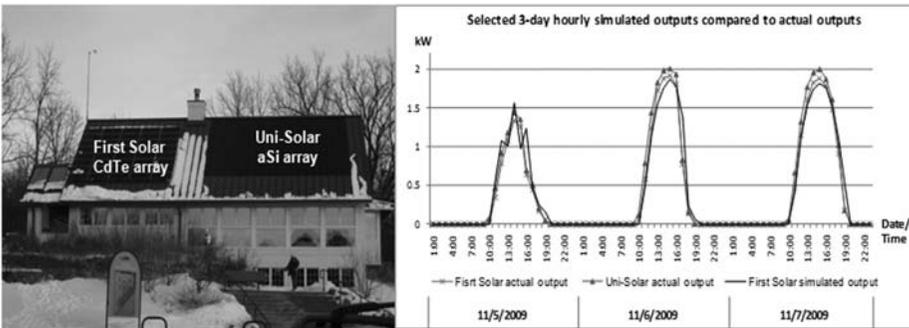


Figure 6: PV systems installed at LNC. SAM predicts PV output within a 3% error compared to actual output

3.RESULTS AND ANALYSIS

3.1 AVAILABILITY

Availability can be defined as the amount of electricity generated from PV systems. This information can be used to select the PV system size as well as the electrical equipment that will be used in the building utilizing the PV system. Using the Ann Arbor TMY3 weather data set, PV electricity output would be 2,684kWh/year. If this number is used, the actual PV yearly output using other weather data sets can vary from -28% (1997 NSRDB data set) to +17% (2002 SolarAnywhere® data set) (Figure 7).

It is obvious from the results that extreme weather that occurs occasionally such as volcano eruptions or unusual weather patterns, is not recognized by TMY weather data sets.

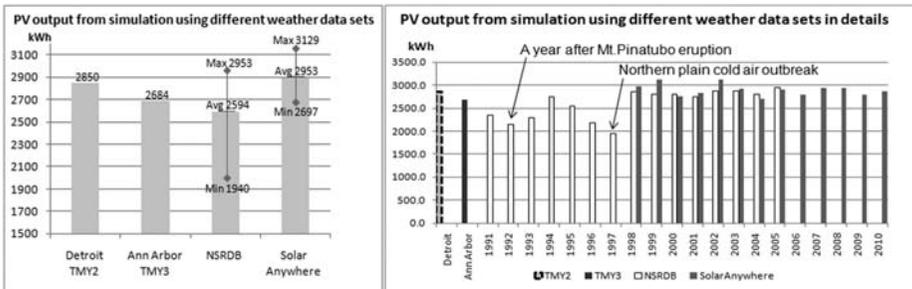


Figure 7: PV yearly electric output from simulation using different weather data sets.

3.2 VARIABILITY

Variability can be defined as how spread out or clustered the data is. In PV output prediction, this can be viewed as how much the PV output per day in each month can vary. Since the NSRDB and SolarAnywhere® are comprised of multi-year data, the maximum and minimum daily average of each month is available. The standard deviation is normally used to indicate variability. It refers to the average distance of data points from the data set average value. The higher the value, the more variable the data. The NSRDB and SolarAnywhere® have similar trends while TMY data sets have more variations. Figure 8 shows daily average PV output in each month, as well as daily PV output standard deviation of each month, from all four data sets.

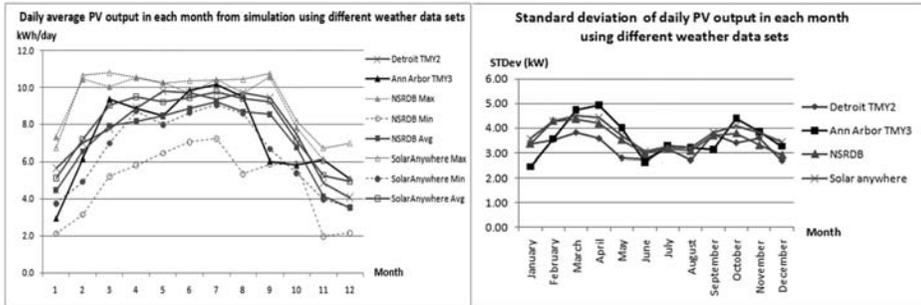


Figure 8: Daily average PV electricity output in each month using different weather data sets

3.3 UNCERTAINTY

Uncertainty can be defined as the chances of each possible event. In this study, each possible PV electricity output from simulations is presented using histograms. The x-axis represents the amount of electricity in kW from a smaller value on the left hand side the larger value on the right hand side. The y-axis represents the frequency of each electricity output value. Yearly histograms of PV electricity output from the NSRDB and SolarAnywhere® in Figure 9 show that shape of the histograms differ from year to year. It can also be seen that the shapes of the histograms are different depending on the weather data sets used. The normal distribution curves show dynamic and variations of weather pattern at the very same locations. The use of average weather data sets or Typical Meteorological Year weather data sets cannot capture these variations. This can indicate that a typical year weather data set might not be proper for predicting PV system electricity output.

Uncertainty can also be defined as an estimate of error. Root mean square error (RMSE) is typically used to evaluate the goodness of the prediction against actual data, especially in the atmospheric field (Yorukoglu and Celik, 2006). RMSE is used to calculate an average magnitude of error. When comparing PV predicted output using TMY weather data sets with PV output from 1998-2010, generated using SolarAnywhere® weather data sets, the difference between the former prediction with the latter yearly prediction is squared. The average of total squared values is then square rooted to find RMSE. The percent RMSE of PV predicted outputs using Ann Arbor TMY3 and Detroit TMY2 compared to those using SolarAnywhere weather data sets were calculated and are shown in Table 1. Even though the yearly RMSE is 4% in Ann Arbor TMY2 and 8% in Ann Arbor TMY3, the monthly percent RMSE values are quite high. They are ranging from 6% to 31% for Detroit TMY2 and 5% to 79% for Ann Arbor TMY3.

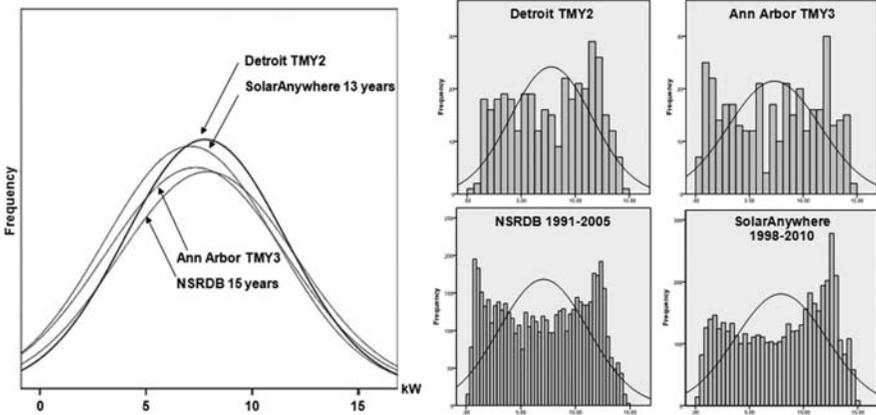
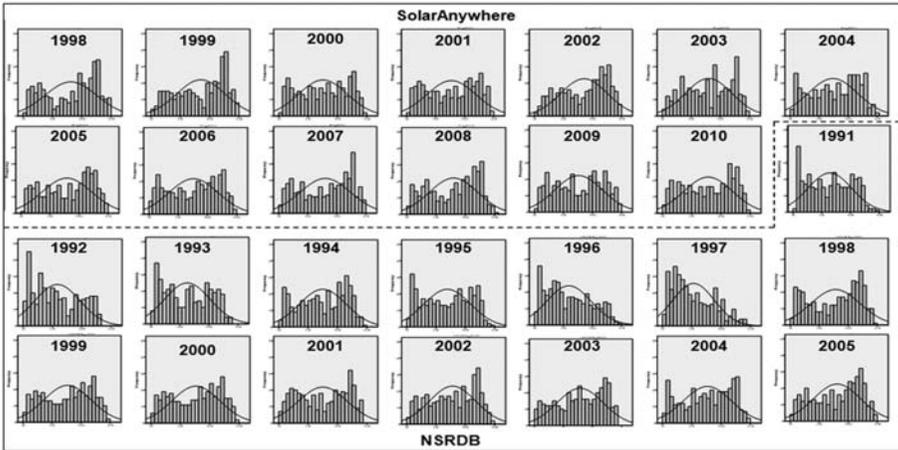


Figure 9: Normal distribution curves and histograms of simulated PV electricity outputs using four weather data sets

Month	Detroit TMY2				Ann Arbor TMY3			
	Total output kWh	%RMSE	Daily average kWh	%RMSE	Total output kWh	%RMSE	Daily average kWh	%RMSE
January	175.3	18%	5.7	16%	91.4	79%	2.9	79%
February	195.4	20%	7.0	21%	172.1	28%	6.1	28%
March	240.8	21%	7.8	20%	289.7	11%	9.3	11%
April	266.3	9%	8.9	9%	265.2	9%	8.8	9%
May	303.7	9%	9.8	10%	261.6	12%	8.4	12%
June	290.7	6%	9.7	6%	294.6	7%	9.8	7%
July	289.7	6%	9.3	6%	314.4	6%	10.1	6%
August	300.9	6%	9.7	6%	294.2	5%	9.5	5%
September	283.2	13%	9.4	18%	180.8	57%	6.0	57%
October	231.7	12%	7.5	13%	180.3	27%	5.8	27%
November	145.8	18%	4.9	18%	182.6	18%	6.1	18%
December	126.1	31%	4.1	29%	157.7	19%	5.1	19%
Average	237.5	13%	7.8	14%	223.7	21%	7.3	21%
Year	3,087.0	4%			2,908.3	8%		

Table 1: RSME for total electricity output and daily average output predicted using TMY weather data sets

CONCLUSIONS

The TMY weather data set is widely used in building simulation tools. However, for particular system performance predictions such as electricity output from PV systems, the TMY weather data format might not be suitable because it cannot capture the availability, variability and uncertainty of solar power that can vary from day to day and from year to year. For Ann Arbor, the availability of actual PV system outputs can vary from -28% to +17% compared to traditional use of TMY3 weather data set. Multi-year weather data sets can capture variation and uncertainty of PV outputs from year to year, while TMY data sets can give only typical performance without a hint of other possibilities. Moreover, both the NSRDB and SolarAnywhere® multi-year data sets show a similar trend in variation and uncertainty even though they are available at different periods. This information is essential for PV system design and operation. When behavior and magnitude of availability, variability, and uncertainty are known, management and operation options can be properly prepared. If multi-year weather data sets are available, they should be used to provide detailed information and better understanding of system performances related to that specific location. The study methodology in this particular location can be used to evaluate the impact of using different weather data sets to predict electricity output from PV systems at different locations and climate zones.

ACKNOWLEDGMENTS

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Historic preservation and adaptive use: a significant opportunity for sustainability

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ABSTRACT:

Recent budgetary perspectives of the current presidential administration indicate that recognition of preservation and adaptive use as a sustainability strategy has fallen short of what it can and should be. With the emergence of programs, such as the United States Green Buildings Council's Leadership in Energy and Environmental Design (LEED™) and the American Reinvestment and Recovery Act (ARRA) funding incentives, it is time to expand the language and interdisciplinary nature of preservation to give a broader voice to enhance the public perception that sustainability stems *from* preservation rather than the common general misperception that preservation and adaptive use of existing older buildings *can not* enhance sustainability in the built environment.

This research explores the basic tenets of sustainability through the integrated lens of social, environmental, and economical factors. Specifically, this research provides insights into a holistic view of interdisciplinary practice. By advancing beyond the current practice of "going green," preservationists can use these factors to promote a greater understanding how reusing existing buildings is a viable sustainability strategy. This presentation will supplement the social argument for community revitalization through preservation and adaptive use by exploring the implications of energy utilization indices, the impacts of demolition and replacement, vernacular climate-based design and low technology comfort strategies that are inherent in many older and historic buildings. Lastly, the findings will demonstrate the economic incentives available and the types of collaborative partnerships and incentive programs that have been used to make a project meet the economic goals of the developer or investor. This latter exploration provides the primary thrust to promote the argument in economic terms that drive the actual realization of a project.

CONFERENCE THEME: On measurement: quantifying sustainability, are we using the correct measures?

KEYWORDS: preservation, sustainability, social, environmental, economics

INTRODUCTION

While not all existing or older buildings are historically significant, their rehabilitation contributes to a sustainable future. Retaining buildings is the ultimate form of recycling. As noted "green" architect Carl Elefante has stated "...the greenest building is one that is already built" (Elefante 2007, 26). Stewardship of the built environment balances social and economic needs and their impact on the built environment and, ultimately, natural environment. Stewardship of the built environment recognizes the value of reusing existing buildings as a means to mitigate the long term extraction and depletion of natural resources and abating the landfill pressures caused by the unnecessary demolition of buildings, the energy needed to create new or replacement buildings and subsequently reduce unsustainable sprawl (Young 2008, 3).

Sustainable design (see Figure 1) occurs where Social (S), Environmental (E), and Economic (E) systems converge with one another. This "SEE" approach includes consideration of all three subsystems in seeking sustainable solutions. Solutions where only two components overlap may be detrimental to the excluded component. For instance, constructing an electrical generation plant may raise living standards (Social), provide jobs and reduce overall power generation cost (Economic) but without attention to the Environment. (e.g., increased air pollution, degraded natural habitats, and accommodating suburban sprawl), the project would not be considered sustainable design.

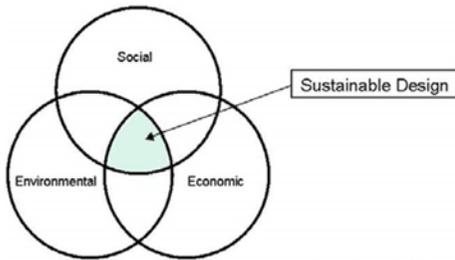


Figure 1: Sustainable design occurs where Social (S), Environmental (E), and Economic (E) systems converge.

I. SOCIAL FACTORS

As a growing comprehensive view of sustainability evolves, various rating systems have emerged. The current front runners in the United States are LEED™ developed by the United States Green Building Council (USGBC) and EnergyStar® jointly developed by the United States Environmental Protection Agency and the United States Department of Energy.

With their focus just on a building and the immediate site, these metrics have created an unintended consequence of “green sprawl,” where green buildings are built where they negate the efforts they make towards sustainability. As an example, the Philip Merrill Environmental Center (completed in 2000) was the first LEED™ platinum building. However, the building site, constructed 10 miles from the original downtown headquarters, has caused many of the 100 employees to drive instead of walk to working. It is unknown how the increased fuel consumption for commuting will offset the energy savings from the new building (Curtis 2008, 23).

Conversely, the sustainability potential of reusing buildings has been undervalued. Early LEED™ systems were insensitive to historic buildings but with the efforts of the National Trust for Historic Preservation (NTHP), the American Institute of Architects, the Association for Preservation Technology, and the National Park Service (NPS), recognition of the sustainability of reusing historic buildings has been added (Kienle 2008).

I.1 HISTORIC PRESERVATION AND ADAPTIVE REUSE

Historic preservation began in the United States in the 19th century and gained traction throughout the 20th century. *The National Historic Preservation Act (NHPA) of 1966* and the *National Environmental Policy Act (NEPA) of 1969* created several federal agencies and programs that included the State Historic Preservation Office (SHPO), the National Register of Historic Places (NRHP), and the Environmental Protection Agency (EPA). The SHPO program created an administrative office in every state. The NRHP was established to certify which resources have historic significance. The EPA was created to review environmental impact statements (EIS) that includes a mandate to “preserve important historic, cultural, and natural aspects of our national heritage” (ACHP 2010).

Based on 19th century attitudes that only the best architecture or buildings associated with famous people mattered, preservation is seen as the purview of the rich who could afford to purchase and preserve these buildings. Vernacular constructions and working class neighborhoods were dismissed and many succumbed to urban renewal programs and interstate highway construction. As preservation oriented groups struggled against this phenomenon, public awareness of the importance of history began to slowly gain support. The period from 1976 to 1986 saw significant increases in historic preservation and adaptive reuse and demonstrated the economic and social benefits of preservation.

Attitudes about patriotism and heritage coupled with the economic recession have people reconnecting with their roots and celebrating their community’s uniqueness. The NTHP advocates the environmental benefits of retaining buildings through its *Sustainability Initiative* which is guided by four core tenets of sustainable stewardship: (1) reuse buildings; (2) reinvest in older and historic neighborhoods; (3) retrofit older and historic buildings for energy efficiency; and (4) respect historic integrity (Moe 2008).

1.2 A SOCIAL CONUNDRUM

The preservation movement has been marked by compounding forces that have occurred unevenly across the country:

- Preservation viewed as anti-progressive
- Laws and statutes that provide multiple paths of oversight
- Issues of perceived civil liberties infringement
- Myths and misconceptions that have perpetuated from these previous forces.

As such, property owners, developers, lending institutions and municipal leaders view preservation and reuse as risky and look to develop where oversight is less or rely on demolition to clear a site.

In 1950, the average house was 218.2 m² (983 sf) which had grown to 218.2 m² (2,349 sf) by 2004 (Solomon 2009). Without local preservation ordinances, neighborhoods are vulnerable to market forces, such as when a property owner wants to expand living space and the result is a “monster house.” The impact on older neighborhoods is twofold: first the architectural heritage is eroded (and consigned to a landfill); and second, the massive out-of-scale structures “threaten the very qualities that make these neighborhoods attractive and desirable.” This trend is an example of how people “carelessly throw away our valuable heritage in the name of progress and change.” (Fine and Lindberg 2002, 2).

Arthur Nelson, director of the Metropolitan Research Center at the University of Utah, indicates that by 2030, households with children will drop to 27% (down from 33% in 2000). Nelson concludes that “single people and households without children don’t want big houses on big lots.” (Kiviat 2009, 57-58). He predicts that they will be attracted to inner-city and first-tier suburban neighborhoods.

By the late-20th century, smart growth concerns over the living in an automobile-dominated culture began to grow. Critics of the smart growth movement saw it as anti-suburb. From the findings of Urban Land Institute’s *Smart Growth: Myth and Fact*™ (O’Neill 1999, 6), “smart growth encourages development that meets multiple objectives in downtown, suburban, and suburban fringe locations.” Suburbs had created social isolation, segregated land uses, an increased reliance on the automobile, and longer commutes which did not appeal to the homebuyer. Smart growth projects located in inner-city and first-tier suburbs include building rehabilitation, redevelopment, new infill, or a combination of these three. In 1999, Richard Moe, president of the NTHP, noted that:

Historic preservation is of critical importance to smart growth advocates. By preserving historic structures, towns and cities can revitalize older areas and preserve the uniqueness of their community. In turn, vibrant downtowns, thriving small towns, and places that are worth saving reduce our appetite for outward sprawl and new development (Sierra Club 1999, 22).

This assertion was later supported by David R. Porter, a growth management consultant, who observed:

Smart growth encourages more growth in urban areas (and less growth in nonurban areas) because growth in urban locations conserves resources, makes efficient use of existing capital assets (building and infrastructure), and adds to the quality of life in metropolitan regions (Porter 2002, 117-118).

Reducing growth pressures at the suburban periphery retains open land, reduces vehicle miles traveled, lowers costs of living by forestalling taxes to build new infrastructure, and encourages greater cultural diversity.

1.3 COLLABORATIVE PRACTICE

Preserving and reusing the built environment can be complex and nearly undecipherable for those unfamiliar with the processes involved. There are many opportunities and constraints in a preservation or adaptive use project that multiply as the scale of the project increases. While each city or town has its own, sometimes idiosyncratic, interpretation of the process, a survey of housing developers in Atlanta revealed the following barriers:

- High land costs
- Neighborhood opposition
- Complex zoning and permitting processes
- Inflexible zoning restrictions and regulations
- The need to design new projects to fit into existing neighborhoods
- The high cost of deck parking (for high-density projects)
- Lack of popular and market support for and knowledge of higher-density and mixed use projects (Porter 2002, 130).

These are fairly typical and become further complicated when the requirements of historic district oversight, government incentive programs, financial institutions, and, as of late, high performance building standards are added to the mix.

To minimize risk and ensure project completion, the collaborative practice strategies have emerged to more comprehensively understand the requirements and facilitate a successful completion. This often has meant forming temporary partnerships between firms in the planning, design, and construction industry. Each firm and consultant retain their separate internal structures but together the partnership emulates the activities of a much larger, more sophisticated organization with broader and deeper levels of expertise. The actual presence of the various entities becomes more pronounced and directly engaged as the scope of work increases. Collaborations may also include federal, state, and local agencies' partnerships with private and public entities.

1.4 TOOLS AND PROCESSES

Preservation and adaptive use of historic and older buildings present challenges to those unfamiliar with them. First, what constitutes a historically significant building; second, when is a building deemed significant, what benefits, protections, and regulations apply to it; and third, what are considered appropriate treatment practices.

The National Register of Historic Places (NRHP) is comprised of resources (e.g., sites, buildings, structures, and objects) deemed historically significant at either the national, state, or local level or a combination of the three. Many states and local governments also maintain historic registers. Inclusion on the NRHP does not automatically place that resource on a local register nor does placing a resource on a local register automatically include it on the NRHP. Although simultaneous listing on the NRHP and local registers occurs, NRHP resources are only added to local registers as local ordinances, staffing, and funding for oversight allows. Designation to the NRHP protects the resource from adverse effect from federally funded projects and provides numerous funding incentives but does not automatically provide local protection accorded to resources on other more local registers.

The Secretary of the Interior (Secretary) administers the NPS and has responsibility for preservation activities pertaining to government interests. The Secretary has defined four types of treatment: preservation, rehabilitation, restoration, and reconstruction. The most commonly used treatment of rehabilitation is:

...the process of returning a property to a state of utility, through repair and alteration, which makes possible an efficient contemporary use while preserving those portions and features which are significant to its historic, architectural, and cultural values (Morton et. al. 1992, v).

The *Secretary of the Interior Standards (SOTIS)* were published in 1976 to codify how alterations could include sensitivity towards historic character-defining features. Subsequently published in 1977, the *Guidelines* “help property owners, developers, and Federal managers apply the [SOTIS] during the project planning stage by providing general design and technical recommendations” (Morton et al. 1992, viii).

The *Guidelines* are the basis for many local design guidelines that aid in creating additions and alterations sensitive to local context. Design guidelines are not uniform nationwide but their goal is to protect character-defining features that can be seen from a public way. The criteria that guidelines follow are based on context cues. Alterations, additions, or new construction must include attention to height, width, and setback, massing, proportion of openings, horizontal rhythms, roof form, and material palette. Design guidelines may also include signage, pedestrian orientation, vehicle circulation, and parking. One aspect that is gaining attention is how to accommodate sustainability. The use of solar panels and photovoltaic panels has hastened this debate as their use may conflict with design guidelines developed before sustainability became an issue.

The NTHP created the National Main Street Center (NMSC) in 1980 to assist local communities in their revitalization efforts. The NMSC provides training and technical assistance through a series of programs for Main Street “managers” and their constituencies. The NMSC has developed the “Main Street Approach” that consists of these four points: organization, promotion, design, and economic restructuring. The NMSC has assisted more than 1600 communities in revitalization efforts over the past 25 years (NMSC 2010c) and currently lists more than 1300 communities in 40 states and the District of Columbia (NMSC 2010b).

2. ENVIRONMENTAL FACTORS

The preservation movement started in the mid-19th century to provide stewardship to historic buildings (and subsequently, structures, objects, sites and the districts that contain them). The ascending environmental movement in the late-19th century emerged from the social imperative of providing stewardship to the nation’s natural resources. By the late-20th century, much of the general public (and unfortunately many civic leaders as well) still perceived these movements as having separate purposes. This period fostered recognition that stewardship of both the built and natural environments have many overlapping goals and the preservation movement became expanded beyond simple nostalgia and emotional attachment in their advocacy efforts. The social and regulatory environment included increased incentives for preservation. In turn, preservationists redefined and broadened their efforts to understand the potential environmental and economic implications of preserving and adaptively using buildings. The important critical aspects of this awareness are accounting for the energy utilization index, embodied energy invested in existing buildings, energy recovery for new buildings, material flows from raw materials to landfill wastes, and life cycle assessment.

2.1 ENERGY UTILIZATION INDEX

The Energy Utilization Index (EUI) is the energy used for heating, cooling, and lighting for one year expressed in kilo-British-Thermal-Units per square foot of the building (kBtu/sf). In a study released by the United States Department of Energy in 2008 (see Table 1), the perception of energy inefficiency in commercial buildings of the 1960-1980 period is true with the 1980 decade after the energy crises being the worst performers. Furthermore, comparing the post-1990 EUIs with the 1950s and pre-1920s EUIs shows an extremely similar EUI between them. More telling is the fact that post-2000 buildings exhibit an EUI that is only *marginally* better than commercial buildings built prior to 1920.

Many commercial buildings built before 1920 were constructed of heavier masonry materials that provided thermal mass, included natural ventilation strategies for cooling, and relied a great deal on daylighting. Air-conditioning, although invented in the early 20th century, did not become widely used until after World War II. The fluorescent lamp and double-paned window, introduced in the 1930s, and the aluminum curtain wall gained greater use in the 1950s and beyond. Eventually, building with operable windows, thermal mass, and other pre-1920 design elements disappeared from the latter-20th century design mindset. With the advent of commercially available nuclear electrical power sources, the promise of electrical power “too cheap to meter” (Adams 2005) led to reliance on larger heating, ventilating, and air-conditioning systems. This expanding cycle of energy use and design insensitivity continued well into the 1970s and was only curtailed by the energy crises.

Period	kW/m ²	kbtu/sf
Before 1920	253.0	80.2
1920 – 1945	284.9	90.3
1946 – 1959	253.3	80.3
1960 – 1969	286.8	90.9
1970 – 1979	299.7	95.0
1980 – 1989	315.8	100.1
1990 – 1999	280.1	88.8
2000 – 2003	251.4	79.7

Table 1: Energy utilization index for commercial buildings (non-malls). Source: (USDOE 2008; conversion to SI by author)

Period	kW/m ²	kbtu/sf
Before 1939	176.7	56
1940 – 1949	170.3	54
1950 – 1959	154.4	49
1960 – 1969	148.3	47
1970 – 1979	145.1	46
1980 – 1989	129.3	41
1990 – 1999	123.0	39
2000 – 2001	116.7	37

Table 2: Energy utilization index for residential buildings. Source: (USEIA 2010; conversion to SI by author)

In the 1990s, energy sensitive designs gained popularity and have taken firm hold of the building industry.

Conversely, newer buildings in the residential sector have lower EUIs (see Table 2) that have prompted a firestorm of outcry for upgrading their energy performance. The major issues prompting this have been largely based on the amount of insulation used in the older buildings, the performance of existing windows, poorly controlled infiltration, and mechanical and electrical system inefficiencies.

2.2 EMBODIED ENERGY

The Advisory Council on Historic Preservation (ACHP) describes embodied energy as:

the energy used to process the materials required to construct the building and that [energy] needed to put them into place. (Advisory Council on Historic Preservation 1979b, 6)

Demolition energy is the energy required to raze and haul away demolition materials (ACHP 1979a, 8). While attitudes of the era did not foster a broad acceptance of these concepts, the NTHP was an early advocate promoting energy savings accrued through preservation and reuse of buildings rather than replacing them.

Carl Elefante has said, “We cannot build our way to sustainability; we must conserve our way to it” (Elefante 2008, 27). When many sustainability proponents talk of creating a sustainable environment by focusing solely on removing buildings and replacing them with new buildings that are more energy efficient, they typically justify the benefits based on just the lower operational energy usage of the new building compared to the existing building. That view does not account for embodied

energy (see Table 3) needed to construct the new building nor the demolition energy needed to remove the existing building and especially disregards the inherent embodied energy within the existing building itself. The demolition and replacement of a building presents a controversial point that many designers and property owners do not tend to understand: the lost embodied energy of the demolished building has significance. According to Mike Jackson, FAIA, of the Illinois SHPO, a new office building may take as many as 40 years to recover the new energy used to build the building. For a new office building, this period approaches 65 years when a building is torn down to make way for the new building (Jackson 2005, 51). In each scenario, the energy recovery period exceeds the expected useful lives of many buildings being constructed today. There is no real return on investment in terms of energy, since following the current mindset of demolish and rebuild or build new would repeat these wasteful practices before the recovery period concludes.

Material	MJ/kg	BTU/lb
Stone	0.79	340
Concrete	1.3	559
Lumber	2.5	1,075
Brick	2.5	1,075
Aluminum (recycled)	8.1	3,483
Steel (recycled)	8.9	3,827
Glass	15.9	6,837
Steel	32.0	13,760
Plastic (PVC)	70.0	30,100
Aluminum	270.0	97,610

Table 3: Embodied energy for construction materials. Source: (CanadianArchitect.com, N.D.; Conversion to IP by author)

2.3 MATERIAL FLOWS

Building construction consumes 40% of world resources and contributes 40% of the material going into landfills (NJN Public Television and Radio 2009). This flow could be reduced by reusing buildings. The “reduce, reuse, and recycle” philosophy has public support when it comes to aluminum, glass, and plastic containers, but falls short when it comes to buildings. Donovan Rypkema (2007) noted that razing a typical downtown building (25 feet wide and 120 feet deep), in terms of landfill impact, would wipe out the environmental benefit gained from recycling 1,344,000 aluminum cans. The Institute for Local Self-Reliance (ILSR) reports that while reusing salvaged and deconstructed materials in their existing form occurs within the renovation sector, this is a small percentage of the market and the remaining materials are reduced to constituent components and combined with raw materials to make “recycled content” products (ILSR, N.D.).

Research conducted on the G. H. Schettler House rehabilitation in Salt Lake City, UT, compared material flows of three alternative cases (Young 2004). Case #1 was the rehabilitation of the existing house. Case #2 was the construction of a similar house in the suburbs. Case #3 was the demolition and replication of the existing house. The study analyzed the material flows including the extraction of new raw materials and the impact of construction and demolition wastes on the landfill. Case 1 realized 85.9% recycled content in the rehabilitated building and had the lowest total impact (43 metric tons (47.3 tons)) on the material flows. Case 2 had lower construction waste, but had an overall material flow (165 metric tons (182.4 tons)) nearly four times greater than Case 1. Case 3 material flows (319 metric tons (351.8 tons)) were more than seven times greater than Case 1. This fully shows how retaining buildings reduces overall demand on resources.

Wayne B. Trusty, President of The Athena Sustainable Materials Institute, which specializes in Life Cycle Assessment (LCA) studies, explains that LCA methodology defines the overall impacts on the environment (Trusty 2003, 2). The analysis has more affinity for new construction as the current associative data is more readily available but applying it to reusing buildings is possible. A 2009 analysis of four historic buildings in Canada revealed that retaining existing buildings had more favorable impact values than replacement with new construction (ASMI 2009).

2.4 REGIONAL CLIMATE-BASED DESIGN

Vernacular building construction practices are based on methods that had been tuned through time to meet local climate demands. Builders understood form as a means to environmental control and the opportunities that passive thermal and lighting systems presented. When appropriately restored, these features can reinvigorate the building's sustainability. When recognizing these climatic adaptations, sustainable technology can supplement these inherent sustainable features without compromising historic character (WBDG Historic Preservation Subcommittee 2009).

Building form, window and door placement, shading devices, thermal mass, and daylighting all enhance comfort without mechanical systems and electric lighting. Vernacular traditions grew in response to local climate and provide insights into passive thermal design (building orientation, size, massing, and ceiling height) and daylighting. Today, these vernacular strategies, used well before modern HVAC and lighting systems came into use, are being re-employed on new buildings.

In the 1950s, as curtain wall and lighting technology progressed, buildings were sealed to enable HVAC systems to control thermal comfort. Many low-technology thermal design principles fell out of use. Buildings became climatically disconnected and depended strictly on electric lighting and HVAC systems for comfort.

3. ECONOMIC FACTORS

The period around the American Bicentennial in 1976 saw significant increases in reusing historic buildings. However, the 1986 tax law changes vastly reduced investment opportunities in these projects. Fortunately, the last two decades have seen incentive programs emerge for historic preservation, low income housing, and new markets as well as a grant program for improving energy efficiency in buildings. Tax credits encourage investment growth in specific directions to offset the perceived risk associated with an activity and are a significant incentive for preserving buildings. Economic success is indicated by job creation and increased economic activity, projects using preservation and reuse well demonstrate these aspects.

3.1 TAX CREDITS AND GRANTS

The federal Historic Preservation Tax Credit (HTC) program was instituted in 1976 and amended in 1981 and 1986. Unfamiliarity with appropriate preservation practices had led to the perception that working with an existing building was more expensive than new construction. The HTC offset some reluctance of working with older buildings. Research has shown that reusing a building will cost about 4% less. However, if the new building includes razing an existing building, then the cost of the rehabilitated building becomes 3 to 16% less than the new replacement building (Rypkema 2005, 89).

Since tax credits occur after the project is completed, many potential investors balked at waiting for them. This gave rise to syndicating historic preservation tax credits at the start of the project where a syndicator buys tax credits at \$0.90-1.00 on the dollar (Historic Tax Credit Coalition 2010, 30). There are two federal HTCs. The first is a 20% HTC available for a certified rehabilitation of a certified historic structure used for income generating purposes. The second is a 10% HTC used on non-historic income-generating buildings built before 1936 that are being rehabilitated for commercial purposes (National Park Service 2009a). The HTC is claimed over six years and is calculated based on eligible rehabilitation costs, construction loan interest and taxes, and a variety of associated fees. Costs for landscaping or expanding the building are not eligible. Many states also

provide preservation tax credits. In fiscal year 2009, 37.5% of the projects certified by the National Park Service included state tax credits (NPS 2009a 19). As noted above, early LEED™ rating systems put historic preservation oriented projects at a disadvantage. Despite this, numerous projects have met the highest LEED™ standards and qualified for HTCs. Some notable examples include the Christman Construction Headquarters, Grand Rapids, MI, (LEED™ Double-Platinum), the Big D Construction Headquarters, Salt Lake City, UT, (LEED™ Gold), and the Ecotrust Building, Portland, OR, (LEED™ Gold) (Tess 2010; Taylor-Wells 2008, 109-112).

The Low Income Housing Tax Credit (LIHTC) program, enacted in 1986, encourages investment in affordable rental housing. The tax credit can be used to renovate existing or construct new rental buildings. For existing buildings in census tracts area designated by HUD as being in particular need of investment, the LIHTC subsidizes 40% of the applicable project costs for existing buildings, claimed over a ten year period. The eligible costs include construction costs (for the low income portion only) and fees. Costs not allowed include the land acquisition cost for new buildings, permanent financing costs, and initial deposits to reserves (Rypkema 2002, 10-11; HUD 2010).

The New Market Tax Credit Program (NMTC) is part of the Community Renewal Tax Relief Act of 2000 and creates new business activity in low income communities. The NMTC is administered by the Department of the Treasury's Community Development Financial Institutions Fund which allocated \$3.5 billion in 2009. This amount was supplemented by \$1.5 billion from the American Recovery and Reinvestment Act. NMTCs equal 39% of the investment and are claimed over a seven year period. The program has financed projects in existing buildings in distressed communities nationwide. One example is the First Security Bank, Salt Lake City, UT, which cost \$20.8M and received \$2.8M in tax credits. This project created 2,842 new jobs and \$4.3M in new taxes (NPS 2010a; USTREAS 2009; USTREAS 2010a; NTCIC 2005).

Another incentive for existing buildings is the Energy Efficiency and Conservation Block Grant program (EECBG) funded by the American Recovery and Reinvestment Act (Recovery Act) of 2009. The Recovery Act funding for the EECBG Program provides \$3.2 billion in grants for energy efficiency and conservation (USDOE 2009). Approximately 2,300 cities, counties, and Native American tribes have been designated to receive EECBG funding to improve energy efficiency and reduce energy use and fossil fuel emissions in their communities (USDOE 2010).

3.2 ECONOMIC INDICATORS

The parameters that are commonly used to measure economic success are property values, job growth and tax revenues, and revitalized communities. These economic impacts are indeed measurable and describe success (or failure) in comparable terms. Property values are a concern for many property owners. As such, one anxiety that arises when talk of creating historic districts begins is that additional regulations that accompany local designation will limit or depreciate property values. Numerous studies show that properties in historic districts appreciate at least as fast as or much faster than similar properties in adjoining neighborhoods.

Job growth and tax revenues gained from preservation and reuse incentive programs are quantifiable. *The Federal Tax Incentives for Rehabilitating Historic Buildings: Statistical Report and Analysis for Fiscal Year 2009* states that from 1977-2009, the HTC programs have created a nominal (not adjusted for inflation) \$55.5 billion in historic preservation activity (NPS 2010a, 2). Subsequently, the *First Annual Report of the Economic Impact of the Federal Historic Tax Credit* further reveals that in FY2008 dollars (adjusted for inflation), the cumulative activity has been the equivalent of \$85 billion in historic rehabilitation at a cost of \$16.6 billion in HTCs and has garnered \$21 billion in federal and state tax receipts. The HTC program has generated 1,815,200 new jobs (Historic Tax Credit Coalition 2010, 12-14). This is equivalent to \$9,145/job or 109.3 jobs created/\$1 million spent.

In FY2009 alone, \$4.69 billion in rehabilitation work was approved for 1,044 new projects which created 70,992 new jobs and 6,710 low and moderate income housing units (out of the 13,743 housing units created or renovated overall). The cost to the government was less than \$993 million (National Park Service. 2010a, 2). This translates to \$13,987 per job created or 71.5 jobs created/\$1 million spent. The Recovery Act creates only four jobs/\$1 million spent (Rypkema 2010). So from just this economic parameter, the HTC is a success.

Building rehabilitation is a significant job creator. Rypkema (2005, 11) has found that at the state level, \$1 million spent on building rehabilitation created:

- 29 more jobs than pumping \$1 million worth of oil in Oklahoma
- 22 more jobs than \$1 million cutting timber in Oregon
- 20 more jobs than \$1 million mining coal in West Virginia
- 12 more jobs than \$1 million manufacturing cars in Michigan.

Rypkema states also that these jobs can be retained indefinitely if 2-3% of a community's building stock is rehabilitated annually (Mize 2009).

Community revitalization-based spending creates a multiplier effect when these funds recirculate through the community. The NMSC reported that a dollar spent on operating a local Main Street program generated \$40.35 in return to the community (NMSC 2010a). As money stays within the local economy, the community becomes more economically sustainable. In appraising the Main Street program, Donovan Rypkema (Rypkema 2008) has stated:

In the last 25 years, some 1,700 communities in all 50 states have had Main Street programs... [T]he total amount of public and private reinvestment in those Main Street communities has been \$23 billion. There have been over 67,000 net new businesses created, generating nearly 310,000 net new jobs. There have been 107,000 building renovations. Every dollar invested in a local Main Street program leveraged nearly \$27 of other investment. The average cost per job generated—\$2,500—is less than a tenth of what many state economic development programs brag about.

This strong evidence of the success in the social context of creating new businesses and jobs is a compelling and yet often overlooked aspect of preservation and reuse. Rypkema (Rypkema 2008) has concluded that this program “is the most cost-effective U.S. program for economic development... of any kind.”

CONCLUSION

Beyond misperceptions and myths about preserving and reusing buildings, the truth is that preservation and reuse can have an integral role in sustainability. Communities that balance the social, environmental, and economical factors stand the best chance at sustainability. As noted by Richard Moe:

We're on the threshold of a new phase as growing numbers of people are concerned about the degradation of the environment and our relentless consumption of irreplaceable energy and natural resources. Preservation certainly isn't the solution to these problems, but it can be—and should be—an important part of the solution (Moe 2007).

Stewardship of the built environment will expand perspectives on how to truly achieve a sustainable environment. The measurement systems demonstrate that preserving and reusing buildings is sustainable. Unfortunately, despite this evidence, public perception still inhibits acceptance of the broader reach that reusing existing buildings provides and perpetuates the “extraction and depletion” mode of thinking that delivered society to where it is today.

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ON RELEVANCE

Building technology research in architectural practice: emerging trends

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ABSTRACT:

This paper discusses relationships between research, architectural design and technology with particular focus on the descriptions and activities of a practice-oriented architectural research program. The objectives of the program are to advance the performance of project designs, improve the decision-making process and to inspire innovation through systematic investigations of building performance and emerging building technologies. First, descriptions of the research program are discussed, such as research objectives and methodologies. Then, two case studies are reviewed that show relationships between architectural design and conducted research, illustrating how research results inform design decisions. The first case study focuses on the investigation of thermal comfort and exterior design elements for courtyard design. The second case study investigates energy consumption studies in relation to façade design.

CONFERENCE THEME: "On Relevance": Identifying emerging trends in architectural research

KEYWORDS: building technology research, architectural practice, building performance, innovation

INTRODUCTION

This paper discusses relationships between research, architectural design and building technology. These following themes are discussed:

- Development of a research program that supports objectives and the vision of a global architectural practice
- Relationships between architectural design and building technology research and how research influences design outcomes.

This paper is structured in the following way: first, an overview of practice-oriented building technology laboratory is presented, which is a part of a leading architectural design firm. Research objectives and studies are determined by the needs of architectural projects. Then, relationships between research and architectural projects are discussed and how research results are used for the decision-making process. Two case studies are presented, one focusing on thermal comfort and outdoor design elements and the second one focusing on façade energy studies.

I. BUILDING TECHNOLOGY RESEARCH AND ARCHITECTURAL PRACTICE

I.1. OVERVIEW OF TECH LAB

Building Technology Laboratory (or "Tech Lab") is an on-going research program at Perkins+Will. The research objectives are to monitor developments in building systems, materials and information technology; review and analyze emerging technologies that can have a direct impact on the course of architectural design; and investigate building systems and technologies that can significantly improve the value, quality and performance of architectural projects (Aksamija 2009; Aksamija 2010).

The operation of Tech Lab is portrayed in Figure 1, illustrating major concepts that relate to the conducted research and dissemination of results:

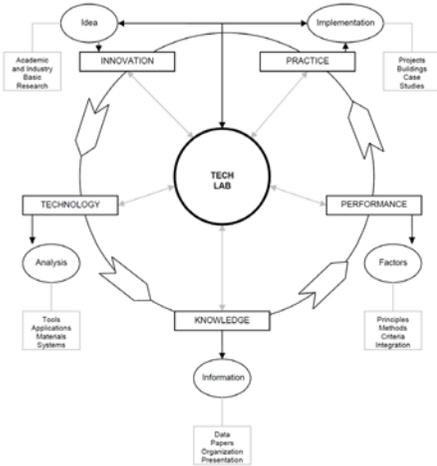


Figure 1: Research objectives and methods.

- *Innovation* refers to basic research and monitoring of developments in building systems, materials and information technology to document emerging technologies.
- *Technology* refers to investigations and technical analyses that are conducted for specific architectural projects focusing on energy performance, daylighting studies and investigation of thermal behavior.
- *Knowledge* refers to collecting information, publishing research results and organizing information databases, presentations and seminars aimed to disseminate research results.
- *Performance* and *Practice* refer to implementation of research findings on architectural projects.

1.2. KNOWLEDGE DISSEMINATION OF RESULTS

Research results are shared internally as well as with the larger architectural and research community. For example, research findings are internally organized in a web-based document library since research findings need to be available to Perkins + Will's twenty-three different offices. This document library can be accessed through local Intranet and contains research documents, articles, white papers, project reports and guidelines, as seen in Figure 2. It is organized based on the topic of interest. Presentations and seminars are often organized to review and present research findings and disseminate results.

Some of the research results and studies are also shared with the broader architectural and research community through publications in external research publications, annual reports and the publishing of the Perkins+Will Research Journal, also shown in Figure 2.



Figure 2: Dissemination of research results.

The next two sections discuss specific case studies that illustrate relationships between research and architectural projects, discussing investigations of thermal comfort and outdoor design elements and façade energy studies.

2.THERMAL COMFORT AND OUTDOOR DESIGN ELEMENTS

2.1 THERMAL COMFORT

Thermal comfort is defined as “that condition of the mind in which satisfaction is expressed with the thermal environment” (ASHRAE 1993). Primary factors affecting thermal comfort are air temperature, humidity, air velocity, mean radiant temperature, clothing and metabolic rate (Atmaca et al. 2007). Mean radiant temperature is a significant factor, especially in areas with higher solar radiation.

Thermal comfort in exterior environments depends on design elements and climatic conditions. The human body reacts to combined effects of all climatic parameters. For instance, mean radiant temperature has the same effect as the air temperature with smaller wind velocities. Hoppe developed physiologically equivalent temperature (PET), which is defined as temperature at any place, outdoor or indoor, where heat balance of the human body is maintained with core and skin temperatures equal to those under the conditions being assessed (Hoppe 1999) . Table 1 presents several scenarios and accompanying PET values.

Scenarios	Ambient temperature Ta (°C)	Mean radiant temperature Tmrt (°C)	Air velocity	V (m/s)	Water vapor pressue VP (hPA)
Typical interior	21	21	0.1	12	21
Winter, sunny	-5	40	0.5	2	10
Winter, shade	-5	-5	5.0	2	-13
Summer, sunny	30	60	1.0	21	43
Summer, shade	30	30	1.0	21	29

Table 1: Selected PET values for several scenarios. Source: (Hoppe 1999)

For example, an occupant in a warm and sunny external environment with an ambient temperature of 30°C, mean radiant temperature of 60°C, relative humidity of 50% and air velocity 1.0 m/s would experience PET of 43°C. Blocking direct solar irradiation would result in a decrease of PET to 29°C. PET is an index that considers combined influences of climatic parameters; however, it is not an absolute measure of thermal comfort. It is independent of activity and clothing and needs to be adjusted according to these characteristics. For prediction of thermal comfort in exterior environments, several parameters must be taken into account, such as wind speed, air temperature, relative humidity, solar radiation, human activity, clothing level and physiological characteristics (Metje et al 2008).

The objective of this study was to investigate thermal comfort for a courtyard design located in Riyadh, Saudi Arabia, which is shown in Figure 3. The rationale behind the research was to investigate whether occupants would use this outdoor space if shading was not provided since these elements were subject to value-engineering. The research questions that were posed were:

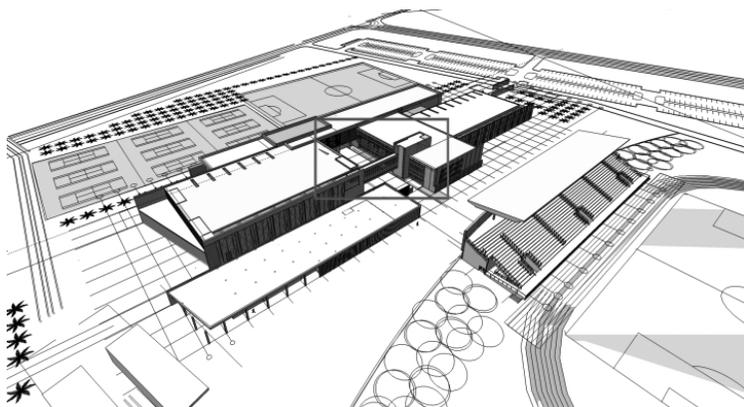


Figure 3: Courtyard design used to study design elements and thermal comfort.

- Would occupants be comfortable in an un-shaded courtyard?
- What would be the effects on thermal comfort and sensation during different months of the year?
- Would the courtyard be a usable outdoor space during milder conditions if shading is not provided?
- If shading is provided, what type of configuration and dimensions would be most appropriate for improving thermal comfort in this courtyard?

Effects of climatic and design conditions were investigated to assess perceived thermal comfort and physiological perception. Thermal Comfort Model, developed by the Center for the Built Environment (CBE) at the University of California at Berkeley, has been used to simulate the environmental effects on the occupants' comfort and thermal perception. CBE's Thermal Comfort Model (TCM) relies on complex relationships between environmental conditions and physiological response of the "thermal manikin", shown in Figure 4 (Huzienga et al. 2001). Thermal manikin represents an occupant within the considered environment. Physiological response is calculated based on the environmental conditions (temperature, solar radiation, wind speed) and relies on the principles of human thermal regulations. Human manikin can be divided into an arbitrary number of segments, but most applications use sixteen body segments, such as head, chest, arms and legs in order to differentiate responses. Moreover, thermal manikin can be modified to reflect characteristics of actual users, such as level of clothing, metabolic rate and physical characteristics. Physiological mechanisms are considered as well as different types of contact with the environment. Convection, conduction and radiation between the manikin and the environment are considered in the calculation of thermal comfort and thermal sensation indices. Spatial properties, such as dimensions, orientation, components (walls, windows) and description and placement of the occupant within the space are necessary for the computation. Non-uniform properties can be prescribed for individual elements where surfaces with higher exposures to sun may be assigned higher temperatures. Procedures for the study and results are outlined in subsequent sections.

2.2 THERMAL COMFORT IN UN-SHADED COURTYARD

Riyadh is characterized by hot and arid climate, and IWEC weather data has been used to determine air temperature, relative humidity, wind speed and solar radiation inputs to the model. Six different scenarios were simulated for the un-shaded courtyard where base scenario was modeled for March. Summer conditions are most critical for this type of climate, where four months were selected (May, June, August and September) to analyze comfort conditions within the outdoor space. One representative month for cold season was studied where January conditions were selected.

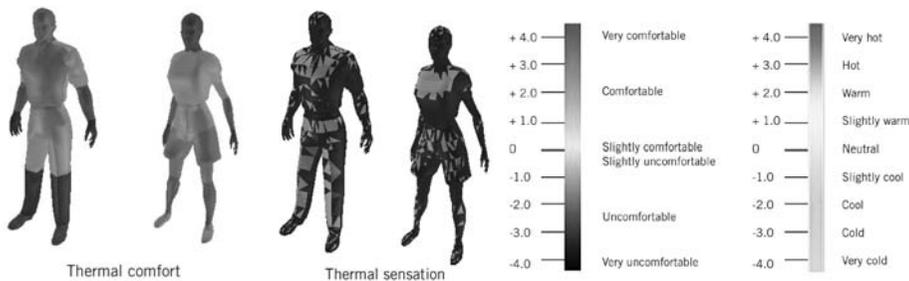


Figure 4: Thermal manikin types and measure indices for thermal comfort and sensation.

The scale for thermal comfort ranges from -4.0 to +4.0 where 0 represents neutral state, -4.0 is very uncomfortable and +4.0 is very comfortable. Thermal sensation is represented similarly where 0 is neutral, -4.0 represents very cold sensation and +4.0 represents very hot sensation, as seen in Figure 4.

Results indicate that without shading provision, occupants would feel uncomfortable and hot during summer months, which is expected in this type of climate. Thermal comfort would improve during winter months, however; results show that occupants would feel warm and uncomfortable even during these milder conditions. Results show that shading is necessary for all seasons and is crucial during hot months; otherwise the courtyard would be unusable. Therefore, subsequent analysis focused on the addition of shading elements and the effects of different configurations (varying orientation, position and dimensions) on thermal comfort.

2.3 EFFECTS OF SHADING ELEMENTS ON THERMAL COMFORT

The months of August and September are representative of the hottest periods and previous results have indicated that conditions in the courtyard would be uncomfortable during the entire year if shading is not provided. August was chosen for analysis of shading effects on thermal comfort. Input parameters were identical to data presented in Table 2 and shading elements were added to the model. Configuration, dimensions, orientation and height of shading elements were varied to investigate effects on thermal comfort, as seen in Figure 5.

Overall, introduction of shading greatly improves thermal comfort and sensation as it is evident from the results. However, dimensions, height, percentage of shaded area, orientation and configuration

	Base model (March)	January	May	June	August	September
Inputs						
Air temperature T_a (°C)	25	20	34	40	43	37
Relative humidity RH (%)	60	70	30	25	25	40
Mean radiant temperature T_{mrt} (°C)	25	16	36	40	48	45
Wind speed (m/s)	2	2	2	2	2	2
Direct solar radiation (W/m ²)	1000	1000	1000	1000	1000	1000
Diffuse solar radiation (W/m ²)	250	250	250	250	250	250
Time (min)	180	180	180	180	180	180
Results						
Thermal comfort	-2.01	-1.58	-2.59	-2.66	-3.05	-3.05
Thermal sensation	2.45	2.08	3.17	3.22	3.43	3.44

Table 2: Inputs and results for thermal comfort in an un-shaded courtyard.

have different effects. For example, reduction in height of the shading elements greatly improves comfort (shading devices that are placed closer to the human body relative in height result in improved thermal comfort). The orientation and percentage of shaded area also influence thermal comfort where increased area and orientation of devices in both directions decrease radiant temperature of the surrounding surfaces and reduce direct solar radiation, thus resulting in improved thermal comfort. Thermal sensation is relatively high for all cases due to extreme temperatures; however, shading reduces direct solar gain and radiant surface temperature. Design strategies that would result in improved thermal comfort and thermal sensation include increased percentage of shaded area, lower height of shading elements in relation to human body, bi-directional orientation and uniformity in the design of shading surfaces. The study used simulations only and further investigation would be needed to analyze actual occupants' thermal comfort (such as through a post-occupancy evaluation).

Properties	Percentage of area	Diagram	Model	Thermal comfort	Thermal sensation
Scenario 1 Width=24 m Length=14 m Height=10 m	46%			-1.69	2.36
Scenario 2 Width=24 m Length=14 m Height=5 m	46%			-0.82	1.97
Scenario 3 Width=15 m Length=20 m Height=5 m	41%			-1.63	2.24
Scenario 4 Component 1: Width=8 m Length=22 m Height=5 m Component 2: Width=24 m Length=14 m Height=5 m	64%			-0.87	1.73
Scenario 5 Component: Width=9 m Length=9 m Height=5 m	64%			-0.89	2.10

Figure 5: Shading configuration, properties and effects on thermal comfort and sensation.

3. FAÇADE STUDIES: ENERGY

3.1 OBJECTIVES

The objective of this study was to investigate building envelope design options and the effects on energy consumption for a commercial office building located in Riyadh, Saudi Arabia. Two completely different design schemes were proposed for this office building, as shown in Figure 6. The design schemes had different building form, orientation and façade treatment:

- Design scheme 1 used vertical fins for shading on single skin facade
- Design scheme 2 considered double skin wall

The study considered different building envelope scenarios for both design schemes focusing on the energy performance. The analysis considered a single zone office space and compared energy consumption for four different scenarios (for both design schemes 1 and 2). Assumed inputs for all scenarios are listed in Table 3.

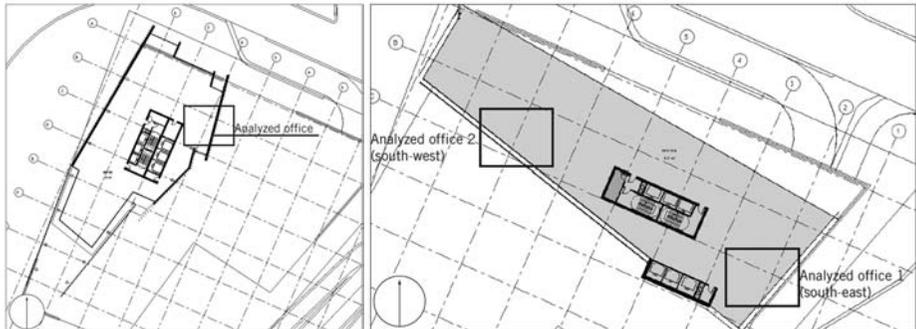


Figure 6: a) Design scheme 1; b) Design scheme 2.

Design scheme 1: model inputs for all scenarios (vertical fins)	Design scheme 2: model inputs for all scenarios (double skin wall)
Space type: office Occupancy: 7 AM to 5 PM Occupancy load: 0.10 persons per m ² Lighting load: 1.0 W/m ² Equipment load: 5.0 W/m ² Room dimensions: 3000mmX9000mmX4200mm Lighting control: dimming switch Facade window to wall ratio=80% Glass type: Reflective Properties of glass: <ul style="list-style-type: none"> • Visual transmittance Tv=0.26 • SHGC=0.30 • U-factor=2.498 W/m²K 	Space type: office Occupancy: 7 AM to 5 PM Occupancy load: 0.10 persons per m ² Lighting load: 1.0 W/m ² Equipment load: 5.0 W/m ² Room dimensions 9000mmX10000mmX4200mm Lighting control: dimming switch Facade window to wall ratio=80% Glass type: Low-e (double IGU), clear (single glazing) Binds used in the double skin air cavity (white)

Table 3: Inputs for all scenarios.

3.2 DESIGN SCHEME 1: PERFORMANCE OF VERTICAL FINS

The analysis considered four scenarios for east-oriented office (as shown in Figure 6a), where the first scenario did not include any shading devices and the rest of the analyzed scenarios included vertical fins as shading elements with varying dimensions as indicated:

- SCENARIO 1: Base model (double air insulated glazing system, no shades)
- SCENARIO 2: Vertical fins (depth 375 mm, spacing 750 mm)
- SCENARIO 3: Vertical fins (depth 500 mm, spacing 750 mm)
- SCENARIO 4: Vertical fins (depth 500 mm, spacing 1000 mm).

Figure 7 shows monthly energy demand for all scenarios as well as cooling and lighting loads. It is evident that vertical fins would result in a reduction in the total energy consumption, mainly reducing cooling loads. Significant reductions in cooling loads would be achieved by providing vertical fins and the best-performing option was Scenario 3 consisting of 500 mm wide fins spaced 750 mm off center.

3.3 DESIGN SCHEME 2: PERFORMANCE OF DOUBLE SKIN WALL

This analysis investigated energy consumption for a typical office space using single skin façade and double skin facade for south-east and south-west orientations. Modeled typologies for double skin are shown in Figure 8. Scenario 1 considered single skin facade with double air insulated glazing

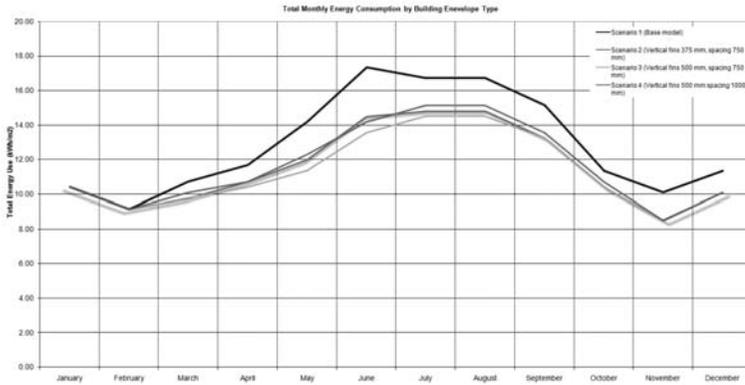


Figure 7: Total monthly energy consumption for design option 1 (all scenarios).

unit. Scenarios 2 and 3 considered exterior vent type double skin where double glazing is placed on the exterior and single glazing is placed on the interior portion of the facade. Horizontal blinds were considered as shading elements placed within the double skin air cavity. Two different air cavity dimensions were modeled (750 mm and 650 mm). Scenario 4 investigated interior vent type double skin where double glazing is placed on the exterior facade, single glazing on the interior side and with integrated horizontal blinds within the air cavity:

- SCENARIO 1: Base model (single skin façade, double low-e air insulated glazing unit)
- SCENARIO 2: Double skin, exterior vent type (mechanical cooling [air flow rate 50m³/h], air cavity 750 mm)
- SCENARIO 3: Double skin, exterior vent type (mechanical cooling [air flow rate 50m³/h], air cavity 600 mm)
- SCENARIO 4: Double skin, interior vent type (mechanical cooling [air flow rate 50m³/h], air cavity 750 mm)

Results for the south-east oriented office space (Figure 9) indicate that double skin facade (all types) would result in increased energy consumption compared to the base case scenario. The base case scenario has the smallest overall energy demand, especially during summer months. Scenarios 2 and 3 (exterior vent type) would decrease cooling loads compared to the base case scenario, however, lighting loads would be increased. This is due to the fact that natural light would have to penetrate two layers of the façade (with air cavity in between), thus reducing the illumination levels. Similar results have been found for south-west oriented facade. Overall energy demand would be slightly increased for this orientation compared to south-east orientation.

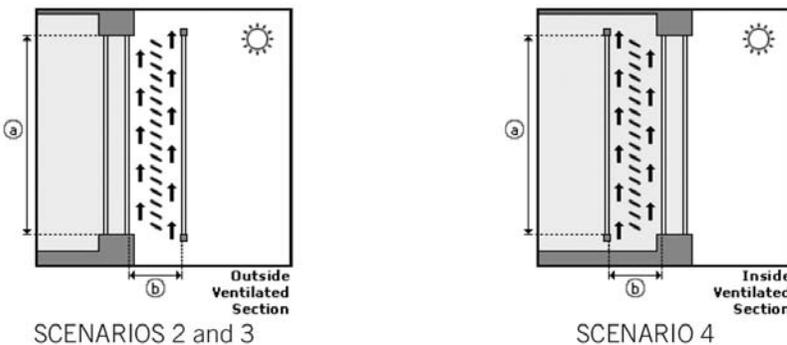


Figure 8: Double skin façade typologies.

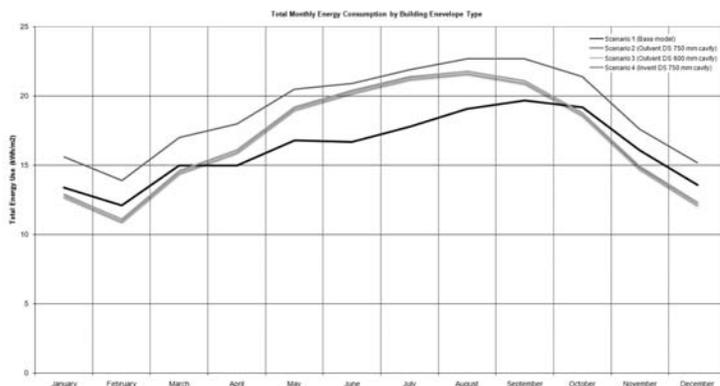


Figure 9: Total monthly energy consumption for design option 2 (all scenarios).

CONCLUSION

Buildings have traditionally relied on technological innovations as well as advancements in building science. Today, innovative materials, environmentally conscious design and new design processes for collaboration, simulations and virtual building are influencing design processes. This has caused convergence of design, technology and research within architectural practices where this synergistic relationship is transforming the traditional nature of architectural research and design. The emerging trend in architectural research is that practice-oriented research programs are gaining popularity, which are integral parts of leading architectural firms. This paper has reviewed objectives and research methods of such a program that focuses on building technology research. The benefit is that the conducted research informs architectural design (and conversely, architectural design informs research since it is driven by the requirements of architectural projects). Two examples have been discussed that illustrate how research and design process are integrated where research results inform the design decisions.

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THE LATER ACT | semiotics < computational craft

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ABSTRACT:

This paper is an interlude in three parts: the semiotic, the formal and the problem of the present. It will attempt to present an outline as to how the discipline of architecture can find a way to begin to turn away from the variability of language as embodied architecture's nod to the sciences and towards philosophy. It is concerned directly with operative use of philosophy in terms of the act of making as tied into the computational turn. We look to the computational turn in architecture as a philosophical problem. This reveals itself in being directly recognised as the familiar philosophical problem of the mind and body; or, as it will be discussed here, the subject-object problem. The reading of the subject-object problem will agree with the ascertain of Pierre Jacob when he stated that perhaps one could derive "intentionality from function and and consciousness from intentionality." It will aim to present us with, as Kipnis ever so poignantly noted in 2007, "the later act" in which we can learn "whether Eisenman's choice ends in comedy or tragedy." The later act of this paper will put forward the term computational craft, a seemingly paradoxical term functioning as an inverse proposition.

CONFERENCE THEME: The role and use of philosophy in architectural research

KEYWORDS: philosophy, computation, craft, application, subject

THE LATERACT 0.0 INTRODUCTION

Anybody who asks, how can we apply the computer to architecture?' is dangerous, naïve, and foolish, because only a foolish person wants to use a tool before he has a reason for needing it. He is naïve, because as the thousand clerks have shown us, there is really very little that a computer can do, if we do not first enlarge our conceptual understanding of form and function. And he is dangerous, because his preoccupation may actually prevent us from reading that conceptual understanding, and from seeing problems as they really are.¹

-Christopher Alexander

I have a confession to make.

I am not interested in architecture.

This may sound like a strange statement for my colleagues to hear, as after all, according to my resume (a great indication of the paradoxes one holds hidden in their history), it seems I have been consistently only interested in architecture. And, to those who have many decades of experience to my one, one can only assume

that I must sound disillusioned and naïve.

The first time I said this to anyone was close to a year ago, and, as any self-respecting woman in her late twenties does, to my mother over dinner during one of my rare trips to my parent's house.

"Ma, I don't think I am interested in architecture anymore."

She stared at me blankly. I tried to explain. She eventually told me to stop talking and, as any mother does, to do the dishes. I obliged, begrudgingly and defeated.

I've come to know that blank stare rather well in the last twelve months. I received it when I said that very statement to my teaching partner, to my boss as he read the first draft of this paper, and to the AA's janitor who I've found myself having late-night debates with in recent months. I received a very mysterious smile from my mentor, who told me only one word in response: 'Enjoy'. And now, I say it to you.

I am not interested in architecture. Let me explain.

The state of architecture in the twenty-first century has been primarily concerned with the unfortunate circumstantial philosophical leftovers of the overlap and paralleling of a phenomenological framework with – as embodied in theoretical practice only – a radical neo-Kantian interpretation by Foucault. While we do not wish to spend much time pondering such known and read philosophical writings, we do need to recognise their relevance to the twenty-first century. The resultant topography of this condition is one which has been encouraged by a growing relationship between architecture – not architects – and language. While this is not unknown, the first protagonists of this Post-modernism emerged out of a consistent effort to free architecture from meanings derived from within and out of Classicism and Modernism. This effort produced arbitrary objects of architecture, removed entirely from cultural meaning. The subject² became the controlling and originating agent of meaning.³ With the advent of new technologies there simultaneously arrived the computational turn; the language of code and of endless formation which is removed from signification entirely.

My interest lies in clarifying the problematic muddled under this resultant indifference. It recognizes that, to blatantly rip from *The Dude* – and this paper will not apologize for this reference – the ‘royal we’⁴ [see endnote] has become profoundly apathetic towards the origin of meaning, in favor of the infinite multiplicity and variation allowed us by a growing reliance on technology. Any interest in architecture – especially as a material, object-based practice – is happenstance, rather than fraught with a sense of self-aware causality. My lack of interest in architecture is not only circumstantial of my generation, but demanded for by the need to disconnect from a practice of architectural theory less concerned with the intentionality behind the object itself than with the multiplicity of form(s) and variations of meaning.

This paper aims to denounce the meaninglessness that was sought in the work of Eisenman, established in the infinite variation of Lynn’s blobs, and further developed in the ‘softness’ of Kwinter, which has pervaded its remains into the inner crevices of the architecture and architectural theory of the twenty-first century. It carries with it a grand umbrella in favour of an interrogation of the present lack of application of philosophy in architecture. This is very different than being interested in architecture. This is also very much the opposite of being interested in architectural theory.

This paper is an interlude in three parts: the semiotic, the formal and the problem of the present. It will attempt to present an outline as to how the discipline of architecture can find a way to begin to turn away from the variability of language as embodied in architecture’s nod to the sciences and back to philosophy. On a more familiar level, it is concerned directly with operative use of philosophy in terms of the act of making as tied into the computational turn. We shall see the computational turn not as a architectural paradigm shift, but a beginning of a philosophical one, as formulated through the subject-object problem.

One may wonder as to the relevance of the broadened scope presented in this paper. This was done purposefully. The later act of this paper will begin to formulate a means to go forward in *computational craft*, a seemingly paradoxical term functioning as an inverse proposition. One should hope that these are not construed as the words of a cynic, but auspiciously working towards a specific practice of architecture. I am not interested in architecture purely because architecture has become too superficial and regurgitated to be interesting. It will aim to present us with, as Kipnis ever so poignantly noted in 2007, “the later act” in which we can learn “whether Eisenman’s choice ends in comedy or tragedy.”⁵

INTERLUDE 1.0 THE SEMIOTIC

When the origination of a concept is studied, the subject – the thinker, in this case, the architect – and object – the thing itself, form, or in this case, the object of architecture – are maintained in a mediation. This can be traced back in philosophy to Kant. Foucault presented this in the following way:

The question which seems to me to appear for the first time in this text by Kant is the question of the present, of the contemporary moment. What is happening today? What is happening now? And what is this ‘now’ which we all inhabit, and which defines the moment in which I

am writing? [...] Now it seems to me that the question Kant answers [...] has to do with what this present is [...] The question is: what is there in the present which can have contemporary meaning for philosophical reflection.⁶

The question of the present can be perceived to be the downfall of all architecture theory since Modernism, when classical forms were representative of their function and their historical meaning. The relationship between the subject and object was formal.

The subject and object do not negate each other as the potentiality embodied within the act of making is mediated. For example, the meaning of the verb *to compute* oscillates pending the presence of an object, from abstract to concrete. The potentiality of computation therefore is determined by the mediated presence of either subject or object. Meaning is varied. This variation in meaning is our site of investigation. It is this hesitation, this moment of pause, which gives rise to the inevitability of the insertion of language into a philosophical playing ground.

The linguistic sign, as it was argued for by Ferdinand de Saussure, is dualistic in that it is made up of two entities – the signifier and the signified.⁷ The sign, as a result of the signifier and signified therefore becomes recognised as the object of linguistics. However, we must recognise that this is a devolution away from the seeming physicality of the Kantian structure of the subject and object, and in doing so, does not necessitate the presence of an object. Instead, in Saussure's semiotic model the subject becomes primary, for not only does the subject originate the concept, but the subject originates the sound pattern – or material element, as Saussure refers to it, as well. This material element, as being related directly to representations of experience,⁸ is most important to our discussion, and will be brought back later in this paper.

There is a correspondence in this oscillation between sign and signifier which enables variations of types of signs. This is referred to by Saussure as the first principle, which states that the sign is arbitrary.⁹ It is the state of being arbitrary that is the most basic truth to the nature of semiotics and of the sign, which, as Saussure puts it, is “arbitrary in relation to its signification”.¹⁰ The second principle of the sign is in regards to the signal, or the object in Saussure's semiotic structure. The signal cannot exist in three-dimensional space, as it is temporal. It is only but a line, or occupies only one dimension.¹¹ It is an auditory, not visual symbol. We can only understand these signals as being part of a series, and “have available to them only the linearity of time”¹² The one-dimensional nature of the sign shows itself immediately when they are representing through the act of writing. The sign is the product of a phenomenological experience, and yet, consequentially, is removed one step further than phenomenology from physical actuality in three dimensions.

There are several assertions which can be made in light of Saussure's conclusions and the previous content of this paper. One is that the connection to architecture can only be understood as a tertiary condition to language – as one understood primarily through the subject, not the object. This is because architecture holds a function outside of its form-making process, and therefore outside of the subject-object problem in semiotics, as well as being physically unable to be found in the third dimension. However, the sign can fulfill the 4th dimension, primarily when considering mathematics. This is an important concept and one which is an underlying investigation threaded, ever so carefully, through the thesis of this paper. When one frames the lack of a direct behavioural element of the sign in light of the sign managing to be comprehended in terms of a 4th dimension, and the other disappointingly obvious and ignored condition – that of the material element of the sign – we find a linguistic principle which fails to relate at all to physical form. The subject and object are broken free from a directly mediated structure. This can, however, enable a relationship between mathematics, biology and metaphorical time. We are now – if we consider the ‘we’ presented in this paper as the linguistic signal – able to contribute to a representation of the 4th dimension (a-physical) with an apathy towards exteriorities (a-historical).

It is here that we find ourselves in the presence of a perfect number of excuses for the application of a semiotic function to architecture. The linguistic sign determines that any object must by necessity have signification assigned to it through an intellectual disciplining, since it is a-physical and a-historical. The subject-object relationship here becomes entirely bound by the capacity of the subject to respond only to linear temporalities, and thus cannot remain architectural when thought

of as in this structure. The mistake is that this intellectual disciplining has latched onto mathematics, time, and as a result has looked to superficial formulations of variability in the sciences for meaning and essence. I do not say this to oversimplify the intellectual efforts of post-Modernism in so far as set the stage for a seeming misappropriation of the sign into architectural discourse. However, I do say this to confirm the cautious statement of Silveti, when he stated that “the use of metaphor in architecture, as in any practice, should be looked at as an enrichment of meaning and not as a replacement for the thing itself.”¹³ One could say that this is setting the stage for the latter part of the later act.

INTERLUDE 2.0 THE FORMAL

The application of the linguistic sign to comprehend form can be traced through the palimpsest of architecture to Egyptian hieroglyphics which were used to literally impart mythological time as an ingredient in the problem of modernity. We again see the imposition of the sign in Classicism and again in Modernism. The linguistic sign presents a radical notion of tradition, which when found in the architecture of Classicism, is found as a representation of a continued antiquity. The Greek orders – Doric, Ionic, Corinthian – are a most obvious presentations of this. Their architectural forms are types of the same element. They perform the same function, yet their forms are arbitrary within that certain historicised function. Saussure confirmed this himself with stating; “the individual has no power to alter a sign in any respect once it has become established.”¹⁴

This is promptly interrogated by Eisenman in his theorisation of the lack of capacity of Modern architecture to break from historical conditions and meaning. This is done primarily through the recognition that Modernism never fully was able to break away from earliest manifestations of its representational tradition, recognised as *abstraction*. However, this abstraction is specific in its relationship to a pure function. It is the language of the function, which Eisenman referred to in his essay “The End of the Classical, The End of the Beginning, The End of the End” (1984) as the “message of utility” – that actually acts similarly to the historical representation of antiquity in Classicism.¹⁵

The subject becomes removed from the object of architecture in terms of any historical representation, thus bringing into the Modernist discuss the moment of modernity and its value outside of form – its function. As Michael Hays stated,

In Eisenman’s view, modern architecture was never fully modern. Though it did produce a certain opacity of the architectural sign [...] modern architecture was never really free of the burden to mean; the referent still survives, albeit problematically, in cherished modernist emblems like the industrial shed, grain silo, and steamship, their workmanlike materials and their social utility.¹⁶

The craft embedded in the utility and function of Modernism could have been the shovel of dirt on Eisenman’s theoretical grave. We find ourselves in the position of confronting Eisenman’s continued foray into displacing meaning from the object, despite a indication that the failures of Modernism to break from the subject of history could perhaps signify a need to respond to the encouragingly superficial nature of the production of Modernist objects of architecture from the point of view of their craft.

Instead, Eisenman latched onto the linguistic model as the way into the search for an architecture of autonomy from meaning. The object of architecture became a result of a purely linguistic system of architecture which cannot embody any sense of meaningfulness, reason, or time. The subject, ultimately, becomes the sign, and signifier of meaning, or lack thereof. Form, as Eisenman stated, becomes;

understood as a series of fragments – signs without meaning dependent upon, and without reference to, a more basic condition.¹⁷

This coincidentally does not take into consideration the linguistic truth that signs can never be removed by the subject from their established set of meaning. The ‘basic condition’, as Eisenman refers to it, can only be understood in this paper as the condition of self-aware consciousness and causality; of being human. The potentiality between the subject and object is unfortunately negated through the insertion of the arbitrary linguistic sign.¹⁸

One could posit that this describes, in a roundabout manner, the negation of the following: a collective consciousness (as determined by Kant), the inscription of function, as well as the notion of time in the third dimension (and therefore a reliance on the linearity of the sign), and the partial appropriation of a philosophical framework as a metaphor for architectural discourse. Through the application of a semiotic systemic, the object, which is no longer of architecture, is presented only through its own codification. Architecture is seen here as dissolved through a coloured lens of philosophy which activated the arbitrary linguistic sign as a means of ordering our world.

INTERLUDE 3.0 PROBLEM OF THE PRESENT

And what a sudden, frightening abyss it opened up in front of us as the computer certainly intimated that it could produce forms that not only do not have precedent, but, more perplexing, may not even have referents! Freedom from semantics, history, and culture was perhaps made possible for the first time in civilization.¹⁹

-Jorge Silvetti

Form in the digital world exists in a 4th dimensional location, one who is removed from the third dimension entirely. The arrival of digital objects into architectural discourse seemingly completes the a-signification so desperately looked for in post-Modern semiotic theory. And, in keeping in mind that what Saussure originally stated was characteristic of a temporal problem of the present, this mode of productivity was diagnosed in a linear manner, from master to apprentice, Eisenman to Lynn.

The language of the sign finds itself being replicated by, or corresponding to, the language of code. However, the exception found within code is that it is able to correspond beyond the linearity of the arbitrary sign, which must be read through a linear series. The language of code has the capacity to, as Greg Lynn has informed us by reformulating a computationally-minded position out of the Eisenman tradition, taking a perspective on the very same shift that Eisenman attempted to outline in his essay referred to earlier;

Architectural form is conventionally conceived in a dimensional space of idealised stasis, defined by Cartesian fixed-point coordinates. An object defined as a vector whose trajectory is relative to other objects, forces, fields and flows, defines form within an active space of force and motion. This shift from a passive space of static coordinates to an active space of interactions implies a move from autonomous purity to contextual specificity.²⁰

This vector-based model is formulated through empirical, mathematical principles, yet has subjected (by the subject) onto its form – or object – the perception that the principle can be read through a language of an arbitrary and varied nature. The object is formed solely by the forces which are dictated to it by the capacity of the technology. The ‘blob’, as it was so keenly named, was the result of this investigation. Its ultimate variation: determined only by its form, with no implied meaning of the subject. It, I would argue, had no material-based object-hood beyond a diluted and implicit linguistic structure. There is no potentiality between the subject and object because the relationship between them has been dissolved.

Although it seems to be here in the computational turn that we achieve the a-signified object, we can see in the work of Sanford Kwinter. In so far as Klee’s *Angelus Novus* represented progress for Benjamin, the blob represented a death of philosophy in architecture, although it did not present the death of theory, as evident in Kwinter’s writing. As digital form became increasingly less material, the technological system which authored it (i.e. the opposite of enabling the potentiality of the subject-object relationship) began to be the focus of the subject. Architecture here is negated, it is a-material, it is soft.²¹

The computational processes of the act of making became central, facilitating the entrance of analogies and metaphors from outside the traditional architectural discourse, and finding root in mathematics and the natural sciences. The production of form was systematised. This signified for Kwinter the potential to break further from the types of Modernism or the fragments of post-Modernism, for their philosophical linearity is superseded by the capacity and potentiality for a non-linear system. Rather than being a product of a relationship between the subject and object, potentiality is now engrained within a system.

We now must look briefly to the computational turn in architecture as a philosophical problem. This reveals itself in being directly recognised as the familiar philosophical problem of the mind and body; or, has it been discussed here, the subject-object problem. The reading of the subject-object problem finds itself agreeing with the ascertain of Pierre Jacob when he stated that perhaps one could derive “intentionality from function and and consciousness from intentionality.”²²

One may have found it easy to forget by this point in this paper that in Modernism’s interrogation of the Classical, and post-Modernism’s argument out of Modernism, both negated the influence of *intentionality* on the making process or in the relationship between the subject and object. This indicates that there are several eccentricities implicit in the work discussed here that has come out of these paradigm shifts which remain to be challenged in only the most superficial of interrogations. Let’s lay it these on the table, shall we? This paper’s commitment to the task of returning to the philosophical origin must be concealed through the very act it aims to dissipate. This act – the act of theorising – enables us to see the failure of our own reason. We aim to ignore our capacity for a Kantian collective consciousness, which is so naturally embedded within our abilities to cognate *potential* and *intention* to the point that we can actively rationalise philosophical distance for the sake of the problem of the present.

However, there could be a way out of the dire apathy for origin, material, form, causality and meaning without having to reconcile with the established distance from the subject and object. This is not to deny the importance of our understanding of principles of computation nor argue against our use of technology in the production of architecture, nor to negate the work which arrived prior. Rather, it is here that I would like to suggest the term *computational craft*, a seemingly paradoxical term functioning as an inverse proposition. We can see this in a few ways. Primarily, one can clearly see that due to and after post-Modernism, we have been unable to comprehend our incapacity to concede to our own humanity. This does not mean to sound prolific, but one must suggest that a slightly alarmed tone is taken primarily due to being shocked at the underdevelopment of the following in philosophy and architecture. It is from Kant that we gain an interest in the first principles of a mathematical, empirical world, but it is also from Kant that we recognise language as a metaphysical sense.

This becomes an inherent contradiction of an application of philosophy to architecture, for finding architectural form within the problem of the present finds that philosophy in a linear sense is exhausted. There must be a return to the Humanist standpoint that there is a material element to the world which cannot be denied. It is not that I wish to continue to find architecture uninteresting. However, it is in the presentation of a neo-Humanist position in reaction to the apathetic disclosure of architecture to a scientific model which emerged from a semiotic model that we find a devastatingly certain closure to Eisenman’s tragedy.

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I am particularly indebted to Ryan Dillon, Michael Toste and Tyson Hosmer, for without their challenging and yet supportive readings of the multiple forms this paper has found itself in, it would without a doubt not be in the state it is in today.

This paper is for my mentor, Mark Cousins, who has never once not nurtured my often incoherent and unsubstantiated intuitions.

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4. I refer here to the cult film *The Big Lebowski* (1998) and to the great practitioners of architectural theory in the latter half of the twentieth century, whose fall into obscurity, primarily in the failure to apply theorization to a material practice, this paper is greatly indebted to.
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18. Obviously, one could continue this discussion through a more thorough investigation into the texts of Deleuze, Guattari and Derrida, but we will only mention their relevance here, in this very note.
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21. A soft system is described as "flexible, adaptable, and evolving, when it is complex and maintained by a dense network of active information or feedback loops, or, put in a more general way, when a system is able to sustain a certain quotient of sensitive, quasi-random flow" in Kwinter, Sanford. "Soft Systems" in Boigon, Brian (ed.), *Culture Lab*, Princeton Architectural Press, 1993: 211.
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Infrastructure, the shipping container, and the globalization of American space

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ABSTRACT:

The shipping container is one of the primary agents of globalization. An object that gains importance through its role in infrastructure, the container's success is due to its ability to work in preexisting national transportation systems, within the identity and space of the nation-state. But in the process those systems are globalized, as the infrastructure that once functioned at the national scale, serving the priorities of the nation-state, is now reoriented to serve international routes of trade and global agendas. The impact of the container on the American trucking and railroad systems is an example. Yet globalization is not merely a top-down phenomenon, and nations and local places have the power to affect global space and to reshape this new worldwide container infrastructure. The study of infrastructure, and more particularly the container, is especially valuable for what it reveals about these ongoing processes. This in turn helps shed light on the dynamics of our global era, and reveals the strengths and weaknesses of some contemporary theories of globalization. The global, national and local are interrelated in a nuanced engagement, in which no one factor is dominant.

CONFERENCE THEME: Identifying or assessing emerging trends and fields in architectural research

KEYWORDS: shipping container, globalization, infrastructure, standardization, United States

I. INTRODUCTION

One of the more subtle yet powerful agents of globalization over the past 50 years has been the humble generic steel box known as the shipping container. In this paper I describe how the shipping container has worked its way into the ground-based freight transportation system of the United States—that is to say, the trucking and railroad infrastructures—and in the process has globalized a system that until recently was primarily oriented towards domestic movement. This is the subject of my ongoing dissertation research in architecture doctoral studies at the University of Michigan. The changes brought about by globalization, and represented in particular by the container, are causing deep changes to national space, as the infrastructures that once served to unify national territories are now increasingly oriented outward, integrating the space of the nation-state into the burgeoning global network of international commerce with its far-flung supply chains and intricate logistics. Isolated faraway places are brought into closer and more direct connections with each other, as a complex dynamic unfolds between global forces and local actions. This paper discusses how containerization is relevant to some of the leading theories of globalization, especially those theories with a spatial component.

I believe the study of infrastructure illuminates aspects of our physical world that cannot be understood through the traditional viewpoints of urban design and architecture. As an architecture doctoral student who has chosen to augment my background in urban design by specializing in infrastructure, I think the infrastructural paradigm is a promising avenue for furthering our comprehension of the built world, and I believe the discipline of architecture needs to pay it greater attention. Indeed, a new awareness of infrastructure's importance has recently emerged, among both scholars and the general public. This has begun to spread to architecture as well, but most of the important and perceptive scholarship on the topic comes from other fields. Architects tend to be interested in objects that are in the foreground, that draw attention—and infrastructure by its very nature generally lies in the background. Yet infrastructure exerts such a powerful influence over how our buildings and cities are constructed that some thinkers in the field of architecture (notably Keller

Easterling, Carol Willis and Alan Berger, among others) are starting to come to grips with it. I hope this paper will demonstrate how my own research, on the impact of the shipping container upon the American transport system, reveals an ongoing series of changes that are perceived most clearly through the framework of infrastructure.

The backdrop to the shipping container's success is the phenomenon of globalization. Examining the container's growing presence in American infrastructure is a way to better understand how globalization has penetrated into and reshaped the territorial space and built environment of the U.S. Globalization is of course having a great impact on the traditional conception of the nation-state, whose powers and boundaries are being eroded, though in what fashion and to what degree is hotly contested. The globalization debate is often long on theorizing and short on specifics, but the container is a tangible presence, one that can be studied and put in the context of various theories. A wide range of ideas and attitudes about globalization have proliferated: that we live in an increasingly interconnected world, that borders are more and more porous, that the nation-state is losing relevance, that the local and global are tied ever more closely together, that place and distance no longer matter, that scale has grown more flexible, that neoliberalism has triumphed over government power, that preexisting systems have been totally reshaped or leapfrogged, that we have made a fundamental break with the past, etc. Understanding the process of containerization can give more nuance to these theories, supporting some and undercutting others.

A brief explanation of the shipping container itself could be useful at this point. The container is a metal box 8' wide, 8'-6" high, and 20' or 40' long (there are variations, but these are the most common dimensions) designed to carry freight cargo, with swinging doors at one end and attachment fittings known as corner castings at each corner. Its size and specifications are standardized at the global level by the ISO. The container's value lies not in any remarkable intrinsic qualities, but in its ability to be carried by multiple modes of transport—ship, truck and train—over the ocean and in virtually every country around the world. Thus the container itself can be transferred between those modes, rather than needing to have its cargo unloaded and reloaded; this represents a tremendous savings of labor, time and money. The container does not improve any single mode of transport, but by linking them all together it makes the overall freight transport network dramatically more efficient, especially at the global level. In the process the domestic transport systems of particular nation-states become more closely intertwined, and the significance of national borders is reduced. A container can be packed at a factory in the heart of China, carried by various means through China, across the ocean, and into the U.S., and unpacked at a warehouse in Kansas City, all without being opened once. Traveling upon the national networks of road and rail, and by shipping over the ocean, the container is an object that spans the entire journey of a global cargo, and creates a global infrastructure out of these disparate systems.

2. INFRASTRUCTURE AND THE SPACE OF THE NATION-STATE

Until recently most infrastructure has been created and instituted at the national scale, for it is the nation-state that has been the most fundamental spatial unit of governance, commerce and society. Defining itself as a discrete territory, a space of control, the nation-state imposes a one-to-one correspondence between the national space, the government, and the social and cultural identity of its people, and so it is the national scale that truly matters for most purposes. This has come to be assumed, to be seen as natural, but is in fact the contingent result of various factors, and in the long span of history is a relatively recent phenomenon (Sassen 2006, 25-140). The great era of modern infrastructural development coincides fairly well with the establishment of the full-fledged nation-state, and infrastructure—transportation infrastructure especially—has often been built at the national scale, with the intent or effect of supporting (or even creating) the nation-state. A classic example is the railroad: the first infrastructure of modernity, it played a key role for many nations in giving coherence and unity to their territories. In the expanding U.S. this was especially true, as the trains covered a vast expanse of land, unifying it both physically and psychologically.

For Americans perhaps the definitive infrastructure of national identity is the Interstate highway system, sometimes referred to as the largest public works project in history. Where the railroad helped produce national unity, the Interstates cemented and deepened it. An infrastructure of staggering

scale, efficiency and standardization, it imposed a cohesive system upon a national territory of great size and variety, making local variations negligible, generating development in less economically advanced regions, and ultimately weaving the nation together more tightly. The degree of uniformity and standardization that undergirds the Interstate system is remarkable, and while the railroads had gradually developed a similar level of standardized rationalization over time, in the case of the Interstates it was imposed by the federal government at the outset. Engineering details like lane width, slope and gradient, minimum turning radius, etc., were made consistent; the emphasis on standardization even extended to the signage.

The infrastructure of the nation-state, developed during a historical period that could be roughly categorized as that of modernity, tended to be characterized by a universalist “one size fits all” approach, with new networks often created from scratch. At its best this approach gave unity and coherence to nations, providing a benefit to all citizens even if it reinforced central power as well, while at its worst it generated some of the bureaucratic nightmares described so well by James Scott in *Seeing Like a State* (Scott 1998). The container infrastructure by contrast is a more flexible one that does not impose itself as an entirely new system, but instead fits into preexisting systems. This seems especially suited to our era of globalization, in which nation-states still control their own territories and wield vast power, for the container works within national infrastructures rather than seeking to overturn or replace them. The crucial point to realize is that this remarkably successful system of globalization, the container infrastructure, does not emerge as a full-blown independent system, nor does it transcend what came before. Instead it depends upon the preexisting networks and routes embedded in the space of the nation-state. These are cobbled together, in effect, to craft a global infrastructure.

3. GLOBALIZATION AND THE SHIPPING CONTAINER

The shipping container moves on routes, within national spaces, that were created long before, for very different purposes and with other agendas. Containerization is not a new dynamic divorced from the past, something cut whole from fresh cloth, but instead is stitched together from elements already in place. The role of history, particularly that of the nation-state, becomes crucial. The American rail network, for instance, has long been focused on Chicago, thanks in large part to that city’s quickness to embrace rail technology in the mid- and late 1800s, in addition to several other historical circumstances. Given that longstanding tradition, it is not surprising that in recent decades the city has become a massive nodal junction for container movement by rail, and container transfers between trains and trucks. Chicago is now a key point on global container trade routes, for reasons that have little to do with globalization or the container, but everything to do with American history and Chicago’s role in it. The realization that containers move along preexisting routes also makes geography and topography relevant. The Mohawk Valley in upstate New York, for example, is a reasonably level path through the Appalachians; it was therefore the perfect route for the Erie Canal, later for a major railroad line (the New York Central’s “water level route”), and still later for an Interstate highway (I-90, the New York State Thruway). The succession of cities that sprang up along the canal—Utica, Syracuse, Rochester, Buffalo—reinforced the route, as it was logical for subsequent infrastructures to serve them. Today the rail and highway routes of the Mohawk Valley are major corridors for container traffic, thanks not to some new global dynamic but rather to their position in the American landscape.

All this stands in marked contrast to much of the contemporary dialogue about globalization, which is often seen as a radical new phenomenon sweeping away the old relics in its path. Enthusiasts of globalization see it as a utopia while critics view it as a dystopia, but either way the past gets overlooked. Thomas Friedman’s superficial *The World is Flat*, one of the most popular accounts of globalization, is typical of this tendency; Friedman breathlessly celebrates a bright new future, a world in which old rules have changed and previous limitations can be transcended, or so he believes (Friedman 2005). He demonstrates little interest in the underlying factors, so rooted in history and geography, upon which our global era is built, and that set the conditions for how globalization is carried out. Aside for the naïve notion that globalization will inevitably be a force for good, Friedman’s viewpoint suffers particularly from the assumption, implicit in his title, that all corners of the world are now on equal footing, with no real obstacles to growth and no barriers between them.

Friedman's central idea of a "flat" world does however possess some validity if one thinks purely in terms of the globe becoming more tightly interconnected, and of course the container is one of the innovations that has made this so. A more helpful and less simplistic metaphor, though, is that of "scale bending," introduced by Neil Smith to describe how local actors are now able to jump across scales and link directly with the global, or to deal with each other across a global expanse (Smith 2004). The concept suits containerization well, capturing how the container allows faraway places to come into an unprecedented sort of close contact with each other—though it is a limited form of contact, that of business and trade. The connections between localities no longer need to be carried out through the agency of the national, nor to make a laborious transition across national borders, but can work more directly from place to place. When scale bends in this way, the local does not merely participate in the global but can take an active agency in it. With regard to the container's presence in American infrastructure, for instance, some localities have been able to make themselves key hubs on global trade routes, while others have languished. The Los Angeles region has been among the most successful: it built up two giant ports (Los Angeles and Long Beach) despite having no natural deepwater harbor, and also constructed a plethora of rail and road connections for container movement, including the crucial Alameda Corridor (Erie 2004, 115-171). Far more humble actors can also leverage the global container network for their own purposes, such as when illegal migrants hide in containers. The global is not simply imposed on the local, therefore, but the two are engaged in a back-and-forth interplay. It is not merely that the contours of globalization have local nuance, but that the global is actively shaped by an accumulation of local factors.

Many contemporary theorists of globalization and space miss this point, so fixated are they on a presumed opposition between the global and local. Two of the most celebrated are David Harvey and Manuel Castells, very different thinkers in most respects. Tethered to a neo-Marxist view, Harvey relentlessly emphasizes global capital's control over space, and hence its immense power over local actors and communities that are tied to particular places (Harvey 2001). Fascinated by the impacts of technology, Castells contrasts the "space of flows" with the "space of places," essentially setting up a confrontation between global flows and local places (Castells 1996). Thus both Harvey and Castells, though insightful and valuable scholars in many ways, create a false dichotomy between the global and the local.

Some other scholars have been more nuanced in exploring the global-local dynamic, granting more agency to the local, but still persist in viewing the global as an all-encompassing force that sets the conditions within which the local can act. Neil Brenner discusses how the urban policies and planning of several European cities are increasingly oriented towards global competitiveness rather than national or local priorities, often with the result that a neoliberal outlook takes precedence over social welfare (Brenner 2004). Stephen Graham and Simon Marvin, in their well-known *Splintering Urbanism*, examine how infrastructure is being "splintered" into different levels of service and transformed to serve the priorities of the global elite. They are especially concerned with how the modernist tradition, which sought to create universal infrastructure available to all, has been superseded by a neoliberal attitude that parcels out infrastructure at varying levels depending on one's ability to pay, sometimes neglecting the poor entirely (Graham and Marvin, 2001). While Brenner, and Graham and Marvin, recognize the important role of local actors in making and carrying out decisions, they still tend to view globalization as a top-down phenomenon, to which the local can only react. They fail to recognize the agency the local may possess, the creativity it might exhibit, or even the raw power it sometimes can exert.

It should also be noted that often a global condition is created in the first place by local or national forces. The shipping container is in fact one such case: it comes from the U.S., where it was introduced by various entrepreneurs in the 1950s and subsequently standardized by the federal government in the early 1960s. The ISO made it a global standard later in the 1960s, but its dimensions were identical to the version the U.S. government had established. So every container in the world today traces its heritage back to the U.S. of the late 1950s and early 1960s, and to the particular conditions of that place and time. As in many other ways, the postwar era of American dominance set a template for globalization (the internet being another example). Yet an object from one locale can be used by other actors for their own purposes, and in recent decades the export-oriented economies of East Asia, China in particular, have exploited containerization with tremendous success. This has resulted

in a vast flow of containers into the U.S., as the wave of globalization now sweeps back over America from abroad, and the nation is impacted in unexpected ways by the very forces it originally set in motion.

4. THE SHIPPING CONTAINER'S IMPACT ON AMERICAN INFRASTRUCTURE

The consequence of the growth in container traffic to the U.S. has been a reconfiguration of the American transport infrastructure, to suit the container and the global flows of trade it represents. Actually, this process has been ongoing to some limited degree ever since the introduction of containerization, but it has certainly accelerated. In the trucking industry, more and more container chassis (this is what allows a typical truck “tractor” to carry a container—it is similar to a flatbed trailer, but customized for the container) have been made available, and a greater number of trucking companies have become involved in container haulage. In addition there have been improvements to certain roads and highways, mainly those serving ports or intermodal terminals. This reflects to some extent a shift in road-building priorities, influenced by the ISTEA legislation that prioritized connections between transport modes. In Southern California especially, the meteoric growth in container traffic from the ports of Los Angeles and Long Beach has been a motivation for expanding road capacity, though making significant upgrades to highways has proved difficult (Erie 2004, 166-168).

The container has caused more dramatic changes to the American rail system. The rising use of trains to carry containers in the 1980s and 1990s brought new and profitable traffic to the U.S. railroad corporations. Having been decimated by trucking since the 1950s, the railroads welcomed the new traffic, though it forced them to change some of their practices and build new railcars customized for containers. The railroads also had to shift their resources to certain routes, particularly the corridors from the West Coast to the eastern half of the country, which now became important segments along the pathways of worldwide container movement (i.e., from East Asia to the population centers of the central and eastern U.S.). Having long carried domestic traffic primarily, these corridors have changed in function and now carry containers on long hauls—their orientation has been altered from a domestic focus to a global agenda. As noted earlier, another result has been a massive gain in container traffic for the Chicago area.

The biggest change for the railroad industry was the development of double-stack railcars, so named because they carry containers one atop the other. Trains consisting of these railcars are known as “stacktrains,” and they have proved highly profitable since a stacktrain can hold about 75% more containers than a normal train of the same length (and length is usually the limiting factor for these trains, not weight). Stacktrains originally ran only on western routes, where most clearances were sufficiently high, but their profitability has motivated the railroads to raise clearances on some major routes in the East as well, despite the great expense involved. One major project, recently completed by Norfolk Southern, is the “Heartland Corridor,” extending from the port of Norfolk across Virginia, West Virginia and into Ohio, which required enlarging numerous tunnels in the mountains (Cauchon 2006). Its vaguely patriotic name notwithstanding, the Heartland Corridor is of course mainly carrying containers with international cargo. A similar project is the “National Gateway,” launched recently by CSX and currently underway; this will connect southeastern ports with Ohio, and like the Heartland Corridor it involves expensive work enlarging tunnels (Boyd 2010).

In addition to the alterations to the road and rail systems, the container has caused another change to the national transport network: the creation of intermodal terminals at particular locations, generally along a major rail line and near at least one highway. Sometimes called “inland ports,” these terminals are primarily used to transfer containers between train and truck, but are also used for train-to-train transfers. Some of the early intermodal terminals were simply modified rail yards, but nowadays the new terminals are usually built from scratch, and being very large facilities are usually located on the exurban periphery of major cities, where land is available and a major market is nearby. Many of the biggest and most important are near metropolises in the central span of the nation, like Chicago, Kansas City, Memphis, Dallas, Columbus, etc. As with the changes to the trucking and rail systems, the development of these terminals represents a reconfiguration of the domestic infrastructure to serve global cargo.

Perhaps the most interesting impact of the shipping container on American infrastructure has been the development of domestic containers. Used in the U.S. and Canada only, these domestic containers are generally 53' long, 8'-6" wide, and 9'-6" high, and hence too large for use in other countries. They first appeared in the 1980s, and their popularity has increased dramatically in recent years. Despite being larger than standard containers, the domestic containers have fittings designed so they can be utilized by much of the same equipment that carries normal containers. In particular, they have castings not only at their corners, but also at the same points as a standard 40' container; thus a crane or any such device used for normal containers can also hold a domestic container. The domestic containers are transferred at the same terminals as normal containers, and often can be carried in the same railcars. Different trailer chassis are used for them, but this is a minor factor. Because domestic containers work within the system already laid down by the globally standardized container, they in turn further strengthen that system. The chain of causation in a sense has come full circle, as the container, originally developed to fit into national infrastructures, now becomes the template around which new elements of the national infrastructure are designed. This confirms the importance of the container and the power of globalization, yet also demonstrates that local and national variations will still flourish.

The many and assorted changes to the U.S. infrastructure caused by containerization have mostly been implemented by actors at the national or local level, such as American corporations, the federal government, state and local governments, and various national or local institutions. Global players, despite their apparent power in our globalized era, have seldom been the ones to make these alterations. This fits well with an argument put forth by Saskia Sassen, one of the most prominent scholars of globalization; she explains that it is usually not global bodies like the U.N., World Bank or I.M.F., or even multinational corporations, that carry out the changes of globalization within the national sphere. Rather, the actions that further globalization are often actually imposed from within, at the national or local level. The nation-state therefore retains much of its importance in this global era, somewhat paradoxically, because it is one of the prime implementers of globalization (Sassen 2006, 222-322).

5. CONCLUSION

Infrastructure is not a glamorous subject, and the shipping container in its own right is a decidedly banal object. But the study of infrastructure can do much to reveal the workings of human existence, and containerization is at present a particularly fruitful infrastructural system to examine, for it helps one better comprehend the nature and dynamics of globalization. In light of what the container reveals, various theories of globalization are strengthened or weakened, and certain new insights can be attained. In particular, the nation-state can be understood as having an integral place in globalization and global space; the global era does not make the national obsolete, but rather depends upon it, at least for the moment. The infrastructural systems of the nation are not superseded or bypassed by globalization, but rather are constitutive in creating the new global systems. Yet these new global systems in turn have a major effect on those very same national infrastructures, and on national and local spaces. The container is a key object in a constant and ever-shifting interplay between the global, national and local.

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Design Research in Search of Direction in Architecture Pedagogy & Practice

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ABSTRACT:

This paper examines the question: should the design process as currently taught and practiced in architecture be modified to incorporate scientific research? Scientific inquiry informing design allows architects think broadly and assume responsibly for developing building designs that are knowledge-driven. Scientific methodology can be used to ensure that a design is adaptable and integrative within its context as well as perform technically, contribute socially, and remain economically feasible. Does this practice currently exist and if not will architects expose them to greater liability? The general standard in architectural liability is one of “reasonable care.” Individuals performing architectural services are performing professional services; the law imposes upon such persons the duty to exercise a reasonable degree of skill and care, as determined by the standard ordinarily employed in the local community. If the community standards evolve, then it follows that the standards for individual architects would evolve. Changes in an architect’s standard of care should be carefully considered before any major shift in design practice, but arguably, the use of scientific research, which brings with it the ability of the architect to use measurable outcomes to inform the final design, may possibly be the best defense in the event of a dispute.

CONFERENCE THEME: Learning and Design

KEYWORDS: pedagogy, research, liability, change

INTRODUCTION

The process of architectural design is increasingly con-voluted—intertwined with ever evolving technical and societal expectations. In recent years, much discussion has been dedicated to the topic and role of scientific inquiry or scientific research within the academe and practice of architecture. The act of research within any branch of knowledge is simply the quest for a reliable and replicable truth. The new, potential truth, or theory is then verified to determine how closely it resembles reality.

I. IS DESIGN RESEARCH?

Juxtaposing theory to reality is not new to the profession or discipline; Luis Kahn believed that during the design and construction of a building the role of the architect should be to shepherd the development of the design from the immeasurable to the measurable, and ultimately back to the immeasurable for society (Twombly, 2003). Kahn’s description of the designers’ task during the measurable phase is strikingly similar to a researcher’s task during scientific-inquiry. The first immeasurable according to Kahn’s is the intuitive aspects of design that give architecture meaning. A highly subjective process, intuition is a cluster of self-interpreted emotions that are commonly expressed as a feeling followed by cognitive thought that attempts to give meaning to that feeling. In this immeasurable phase of the progression, the cluster of emotions and subsequent feeling are neither reliable, since we cannot be sure an interpretation is accurate; nor replicable, because the resulting design based on a particular feeling is not likely to yield the same design in another instance.

Following Kahn’s immeasurable phase is the measurable. The measurable phase includes isolating, examining, and measuring a given set of variables within a design idea. Any skilled practitioner in the world can achieve the measurable phase with a high probability that the results will be similar to the first set of measurements. The process is predicated upon the practice of correcting for external

variables that may interfere with standardization. Once measured, according to Kahn, the building is built and takes on an immeasurable quality related to its meaning, this is expressed as the second and final immeasurable phase.

Generally, the first immeasurable phase is conceived of in the design studio and then the measurable phase occurs once the design has been visually communicated to the implementer. This sequence of design and then build tends to be most familiar to designers. What if an immeasurable abstract idea embarks on a measurable process of form making, with consideration of materiality, detailing, and construction, all within the studio? The result would be that the poetics of design could be expressed from the beginning of the design through to the building's magnificence as an artifact. Put another way, the first phase of immeasurable can be combined with the measurable phase in the studio. This alternative paradigm allows the building to finally evolve as an artifact with immeasurable qualities. As Louis Kahn believed:

A building has to start in the unmeasurable aura and go through the measurable to be accomplished. It is the only way you can build. The only way you can get it into being is through the measurable. You must follow the laws, but in the end, when the building becomes part of the living, it evokes unmeasurable qualities. The design involving quantities of brick, method of construction, engineering is ended and the spirit of its existence takes over. (Kahn, quoted in Green, Louis I. Kahn, Architect, 3).

Essentially, Kahn believed that every aspect of a building design must meet the requirements and expectations of its occupants; and, it is through this evaluation that the building will be judged by society.

If we are to embrace the scientific view of research within architecture, Kahn has already given us the genesis of a framework. The initial design exercise would and should be free from the constraints inherent in the research process. Once a design has been imagined it would be evaluated for its ability to satisfy society's expectations. During this measurable phase, objective inquiry will determine if the immeasurable first concept can withstand societal demands and scrutiny; if not, the architect must revert to the immeasurable. This perspective, demands that the architect create a design by developing ideas that are then vetted against data representing society's expectations; thus yielding to the development of intuitive and meaningful design solutions. In this way, Architectural design is a reflection of the societal trends and expectations with the outcome demonstrating available industrial and technological means related to its circumstance. This kind of architectural process supports Aristotle's notion that architecture imitates human action and life (Shusterman, 1997). The question is therefore, should the design process as currently taught and practiced be expanded to incorporate scientific research?

1.1 CURRENT TRENDS IN RESEARCHING THE BUILT ENVIRONMENT

Aspects of scientific inquiry are entering the built environment's consciousness from multiple entryways including construction education, engineering, psychobiology (the study of human-environment interactions), and information management technologies. The ways in which these peripheral disciplines and professions influence architectural design is becoming more profound, and thus society's expectations of modern buildings has increased. For example, a smart building may be expected to self-monitor weather conditions and respond in a way that the negative effects will be minimized. Smart buildings are also expected to comply with issues of human health, safety, and welfare, as well as enhance the psychobiological experience of the occupant. This might happen by the building sensing that carbon dioxide levels have become too high and thus allow more exterior oxygen into the building. Similarly, among the most profound advancements within the past two decades are in relation to information technologies. Updated buildings are expected to have standard internal communication systems that cause the building systems to respond to a crisis and external communication systems to alert emergency personnel. Currently, heat-detecting sensors can cause a building to close or open programmed doors while notifying the fire department of the potential threat.

The way in which a technological development performs under differing conditions, and responds to societal demands is an area requiring exploration. This need necessitates that some of the

immeasurable aspects of design to become measured. These technological demands, however, must be balanced with the expressive needs of a building's identity and remain congruent with its contextual fabric, while satisfying the global community's demands for sustainable practices. These multiple, and sometimes conflicting, factors complicate the design process so much so, that the discipline and practice of architecture is in a constant state of flux. The result is a bifurcation within the profession whereby the non-analytical thinker runs the risk of omitting one or more vital factors within the design. Is the answer, to require a rejoining of the industry? What if scientific research were required to be a part of every building design?

2. REQUIRING SCIENTIFIC INQUIRY IN BUILD-ING DESIGN

Although a shift in the design processes of practicing architects maybe desirable and almost inevitable, strategic implementation of these additional competencies for the future members of the profession will be necessary. Who shall take on the responsibility for the implementation of this shift is unknown, but the implementers should include leaders from the academe and practicing architects to be successful.

Society's demands on the profession of architecture may have the too-late-to-notice result of causing additional legal responsibility for the already heavily burdened practicing architect. The extent to which exposure to liability may be affected by a shift in design methods is generally related to tort law as opposed to the more familiar contract law. With a contract, the parties can stipulate who requires what duties—and how the risk will be shared. On the other hand, tort law is intended to protect the general disinterested public; when injury occurs to persons, property and most recently, economic gain. Under tort law, the liability imposed is a duty of “reasonable care” for others. For architects, the definition of “reasonable care” has evolved over time, but remains within the realm of health, safety and welfare. Courts view health as the biological and psychological conditions that result in physical or psychological injury; safety as those aspects of the environment that can cause physical and psychological harm; and welfare as the healthy social and physical interactions of the people within the building. It is this broad tort theory of responsibility that may be enlarged as new requirements for designers to use scientific research are incorporated.

2.1 DESIGN AND CIRCUMSTANTIAL CONTINGENCIES

One way of defining or delineating the components of a design process is through the lens of Circumstantial Contingency Theory, which provides a structure to address deficiencies through improvements and later to form a strategy for future research (Donaldson, 2001). Within a design paradigm there are several types of circumstantial contingencies of the built environment. These contingencies fall into three groups of participat-ing variables: “exact” contingencies, “probable” contingencies, and “improbable” contingencies. An “exact” contingency is related to the active and projective per-formance expectations of the building that are both quantitative and qualitative. Examples of “exact” contin-gencies are the building's structural, acoustical, and environmental performance. Compare “exact” to “probable” contingencies which are related to the building's passive needs that are intangible, such as cultural reflections as demonstrated through symbols and iconography, social perceptions pertaining to ideas of beauty, and personal demands for a positive and gratifying experience within the building. It is the “probable” contingencies that lead to meaning of place and place attachment (Kopec, 2006). Furthermore, an “improbable” contingency is highly subjective and individualistic by nature. This contingency is related to the individual thoughts and aspirations of the architect, and will often require explanation. Renzo Piano's Centre Cultural Tjibaou, for example, while being a well-regarded design requires explanation as to his thoughts and intentions. His peers continually critique Piano's work in relation to these thoughts and intentions.

In short, “exact” contingencies demand objective re-search methods that contain measurable variables for an outcome that is reliable and replicable. “Probable” contingencies are more subjective and thus require a high degree of precision of the variables being researched. With “probable” contingencies the research outcome is reliable, but the subjective nature of the variables, such as differing perspectives of people changing with location, often render a subset of the research variables non-replicable.

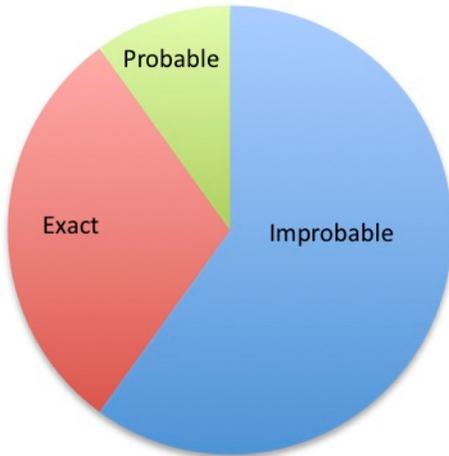


Figure 1a: Speculative interpretation of primary stakeholders views-The Academe

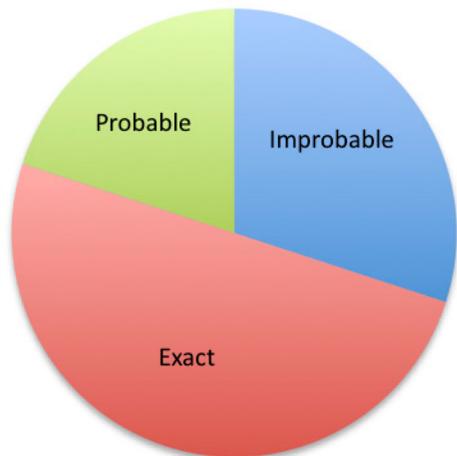


Figure 1b: Speculative interpretation of primary stakeholders views-The Profession

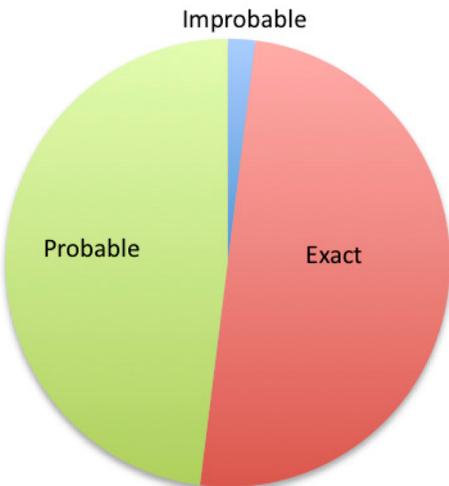


Figure 1c: Speculative interpretation of primary stakeholders views-Society

“Improbable” contingencies, while personal and emotionally driven, may be deconstructed through a reductionist approach into objective parts of a whole. This deconstruction may diminish the essence of thought and purpose. According to Gestalt theory interpreted for the built environment by Kopec, (2006) the whole is greater than the sum of its parts, meaning that the full value of thought and purpose will diminish when broken apart. From the three contingencies, much discourse has been initiated within the academe, profession, and society at large with regard to the role of the architect, and the relative emphasis placed on—and prioritization given to—these three groups of contingencies through-out the design process.

To complicate matters further, arguably built environment stakeholders, who include the academe, the pro-fession, and society at large, determine the relative importance given to the three design contingencies (see Figure 1a-c).

Twenty-first century practice, as well as cutting-edge pedagogy, demands greater understanding of methodologies and the unique scientific inquiry of adapting to projective modes of design processes.

Additionally, it is becoming vital for a practitioner to be proficient and access the flow of information derived from peripheral disciplines and practices, as well as possibilities brought about by the gamut of academic, professional and societal expectations. The result of scientific-oriented design in recent decades uncovered that, what was long held to be immeasurable could now be measured with the development of techniques and sophisticated tools (Galtung 2006). It just maybe through the use of measurable attributes; architects are able to redefine the profession to withstand overwhelming complexity and negative judicial ramifications.

The academe being more theory oriented tends to emphasize the improbable, while the profession places a higher emphasis on exactness. Conversely society often has little regard for the improbable and places importance on probable and exact. It is this discrepancy in perspective that often leads to disagreement and in some cases confusion.

2.2 ARCHITECT LIABILITY

When one thinks of judicial ramifications “architect liability” is at the top of the list of concerns and when one studies architect liability, a discussion of the historical, super-human genius known as the master builder emerges. Reportedly, this person was the individual responsible for the entire building procurement process; including pre-design, design, material selection, cost management, planning, scheduling and ultimately construction of the structure. Even after the building was complete the master builder continued to be responsible. Tort liability of the master builder was severe, and literal. Master builders were held to the strict liability theory of ancient Babylon. According to the Babylonian Code of Hammurabi of 1775 B.C.E., a master builder was directly responsible for any harm resulting from the structure designed. The remedy granted an injured party was easy to calculate—the same injury suffered by the aggrieved party was inflicted upon the master builder. This strict liability idea was continued under the Roman doctrine of *lex talionis* or an eye for an eye, a tooth for a tooth (Edwards, 1971).

During the Renaissance Era not only was Western Civilization’s collective thought experiencing a rebirth, architects such as Filippo Brunelleschi and Andrea Palladio reinvented the master builder’s role. The new process reemerged as two distinct processes: design, which was now the purview of the architect; and construction, relegated to a new entity responsible for implementation. It was believed that the architect should provide the basic design and the constructor should rely on commonly understood engineering principles to complete the project (Trotter, 1999). This idea has continued to exist in some form until the present day.

Under early American law, liability of the architect was limited. Privity of contract determined the scope of an architect’s liability to third parties for breach of contractual duties. This doctrine of *privity of contract* was reflected in business practice because the architect was not liable to parties outside of a contract unless the architect committed fraud or was involved in collusion. Even those parties bound by a contract had narrowly defined duties to signatories to the contract (Trotter, 1999). Unless negligence was involved, without a contract the architect seemed immune from legal liability.

Historically, the architect was released from liability at the “substantial completion” phase based on two main defenses, the lack of privity between the design professional and the injured party and acceptance of the work by the owner. This practice persevered in America until the 1960s when the laws of torts and contracts experienced a major transformation.

Currently, privity of contract is no longer a bar to a negligence lawsuit against an architect. This means anyone claiming that the architect was negligent can prevail in a lawsuit. The law still gives some protection to the architect, even though an architect is required to perform contracted for duties without negligence, the owner cannot take an alternate route and use tort law to impose additional duties on the architect. Since the 1960s, because of key factors such as the increase in litigation; financial leveraging prompting the necessity to shift the burden of funding unexpected events away from the owner; the addition of more parties to the project causing fragmentation and defensiveness; the expectation of the architect has increased. The architect is required to provide almost flawless drawings and specifications with greater levels of detail than ever before (Trotter, 1999). Likewise, the architect is also responsible to comply with research-based evidence as it applies to human health and safety.

It is no secret that the liability of design professionals including architects has increased exponentially in the past decade. Reasons for the increase cannot be placed solely on the highly litigious culture that has evolved in the last century in this country. Additional drivers such as the neglect of individual practitioners to remain current, to evolving technologies and societal expectations are also to blame. For example, society demands greater design research that at times, seems to rise to the level of scientific inquiry.

3. RESEARCH RESOURCES, EVIDENCE AND TOOLS FOR FORM-MAKING

Research in architecture relies on resources from various disciplines, including but not limited to natural and social sciences. Currently, intellectual data from behavioral science, biology, mathematics, and physics, constitute the bulk of resources available to the architect. The viability and credibility of this data has been revealed from those projects where it has become assimilated into the design process. The collected and aggregated data is analyzed and evaluated based on a series and interconnectivity of selected logics in response to the unique context of a project and governing laws. The relationship between research and law are not mutually exclusive. The law often facilitates research in terms of what should be 'reasonable' and research informs the law by clarifying what is actually 'reasonable'.

The use of research within design has been limited thus allowing other disciplines to arrive at architecturally relevant research findings, which has in turn informed litigation patterns. This remains so because design-oriented research differs in logic and meaning from scientific inquiry. As stated above, fundamental principles of research are the ideas of reliability and replicability. Hence, logic within this context is a derivative of viable and credible findings obtained from a rigorously implemented research method from which the results have been critically analyzed and vetted. Within the design process a logical conclusion might be based on opinion, preference or assumptions related to precedence studies that were also based on discretionary assumptions. This is not to say that opinion, preference, and assumptions have no place within architectural research; in deed, the artistic process calls upon self-reflections to stimulate the creative process, which are thusly reflected within a design. However, this subjective process only accounts for one piece of the greater architectural process and is given little credence within the judicial system. The courts often rely on empirical evidence that can only be obtained from rigorous research when determining fault.

Throughout the design process an architect must remain responsive to the moral and ethical obligation to satisfy societal standards and expectations for public health and safety. These standards and expectations have been developed based on empirical research obtained through quantitative and qualitative measures, and in many cases enforced through the judicial system. This reality has the capacity to transform design logic and intent, and thus drive the design outcome. However, this need not be the case. Rules and regulations can be reconceptualized as opportunities for the expansion of creativity. Hence, the regimented scientific inquiry incorporated into a design process should be embraced and seen as an opportunity for nurturing a higher level of design creativity and productivity. Acceptance of this fact as an inevitable phenomenon or trend is a cultural transformation for mainstream architects.

3.1 CURRENT PRACTICES IN FORM-MAKING

The current practice of form-making encourages morphogenetic techniques in design through simulation and modeling which have been enhanced by Architectural Computer Evaluation software. Various computer software have introduced a dynamic mode to design that allows for continual examination based on temporal and situational changes. More specifically, any given design can be evaluated against an area's temporal or climatic ecology. Through an examination of temporal factors we can see the way natural daylight effects interior spaces throughout the course of a day and throughout the year. We can also measure the building response in terms of heat gain or loss, potential distractions arising from the sun's reflections from the building, and the length and types of shadowing created by the building (i.e. the new proposed building could impede the performance of an existing building during select times within a year because of shadowing). Climatic conditions

is another variable that can be measured through computer simulations and modeling. Blizzards, ice storms, hurricanes, blistering heat are only a few climatic conditions that effect buildings. Hence a buildings performance in Boston would be different in Phoenix. Through computer simulations and modeling we can identify areas where design can be modified to compensate for the changes.

4. CHALLENGES OF DESIGN THEORY IN PRACTICE AND PEDAGOGY

Today the licensed architect holds greater accountability by society and the judicial system. As previously noted, the process and expectations of architectural design and practice, as well as pedagogy are amidst evolutionary challenges that include the emergence of new, innovative, and energy efficient materials, along with novel techniques of construction and compliance with the latest rules and regulations. Adding to this are the changes in program types and the demand for life cycle evaluations that require continued learning and consideration. Hence, the architecture profession, along with the educational institutions within advanced societies is becoming more accountable for the empirical research and scientific inquiries to justify a prominent presence, market compliance, and human health, safety, and welfare.

During the past three decades, notable architects such as Grimshaw, Herzog, Piano and others have pursued performance forms in their design projects that reflect a commitment to social and environmental objectives, and active pursuit of scientific inquiries as they pertain to technological advancements. Additionally, active involvements of research institutions (e.g. Massachusetts Institute of Technology, Cornell University, and Lawrence Technological University to name just a few) have developed solid research programs that have successfully combined traditional design processes with scientific inquiry. As a result, the created form works in harmony with measurable objectives and immeasurable aesthetic aspirations. From an analysis of select works by Grimshaw, Herzog, Piano we can better identify where and how solid research methods can be built into the design process without compromise to the immeasurable.

4.1 GRIMSHAW

Nicholas Grimshaw's British Pavilion in Seville, Spain is an example of how to pursue empirical scientific inquiry as part of the design process. The main concept of this building was inspired by technological achievements expressed within the architecture for climate control, specifically for the extreme microclimate of Seville. Being the hottest place in Europe, the architectural design needed to be responsive to the extreme heat of a hot and arid climate. The building incorporated several structural and architectural features such as a waterfall on the façade of the eastern facing wall. Water runs planar with the wall upon the large glazed area. The water wall is powered by solar panels located on the roof, and the effect is the creation of two cool zones. The first zone is the exterior holding area for the visitors awaiting admission to the building. The second zone is within the interior space. This particular feature not only moderates the climate through passive (solar powered) energy sources, but also inspires an associative visual and thermal cooling effect that sets a tone for the overall character of the building. The latter effect is obtained from the volume of water that spills over the wall, which then absorbs almost all the infrared components of light, while allowing the rest of the visible spectrum to enter the building. Likewise, the falling water contributes to the building's aesthetics by creating focused skin transparency.

On the western wall, which receives direct sun light during the hottest part of the day, are stacks of shipping containers filled with water. This feature provides thermal insulation to the building because of the water's capacity to absorb heat. The north and south walls are composed of PVC coated fabrics, similar to the sails of yachts, that are fixed to bowed steel tubes. The building's south side is composed of a second layer of sail-cloth angled similarly to louver strips. This second layer provides added protection from the sun's effect on the facade (Eco-Tech, 1988).

Grimshaw's main theme for the building's design was climate and energy. His early sketches demonstrate the inception of passively moderated space between the extreme outside temperature of Seville, and the interior air-conditioned pods. The idea was then researched using the scientific method whereby different surfaces of the building were tested to ascertain each surface's response to

the sun's angle. As a result of ecological and climatic analysis and studies, a performative enclosure was designed. The performative and intelligent enclosure of this building thus allows the skin of the building to actively compensate through morphogenetic means for the deleterious effects of the sun and other natural elements (e.g. water and wind). The resultant architecture was the creation of a technical biosphere, with different morphing abilities that can transform or simply move from one state to another in a continuum of time and space.

4.2 THOMAS HERZOG

Herzog's Youth Education Center, Guest Building in Windberg Germany, demonstrates an elaborate distribution of topological requirements for interior spaces. This is related to the type of building, and 24-hour programmed use of space. In other words, the allocation of the interior spaces was based on the function, disposition, use within a 24 hour cycle, and duration of time in the space. These factors thus led to the distribution of spaces within the interior volume of the building and overall ambiance of those spaces.

The interior uses and composition of interior spaces influenced the development of the exterior design and overall energy concept. Interior spaces were programmed and material selected based on temperature curves along the south-facing exterior wall of the building. Herzog used the positioning of auxiliary spaces to shield primary spaces, which he positioned deeper within the building in order to shield them from external temperature extremes. The northern tract, which tends to be colder, was dedicated to interior auxiliary functions such as circulation route, storage spaces and sanitary facilities. These spaces shield the interior primary functional spaces of the building and are able to withstand lower average temperature because the occupants only use those spaces for short and intermittent periods of time.

One of the main outcomes for this building was to use the sun as a source of internal heating. The use of translucent thermal and insulation material, as well as the external projection and incorporation of louvers to this facade was done to create thermal energy storage within two extreme temperatures. The design intent was to create a duality of functions for the enclosure system using the familiar concept of a trombe wall for heat storage, and as a barrier to heat loss. This was accomplished in an innovative, novel, and aesthetically pleasing manner (Kolarevic-Malkawi, 2005).

4.3 KAHN'S DAYLIGHTING CONCEPT

Louis Kahn's daylighting concept used for the Kimbell Museum revolved around the use of leafs which would provide natural lighting within exhibition halls, by direct-ing indirect light from the roof. Thomas Herzog later adopted a similar concept for his design of Sprawling Design Center, Exhibition Hall in Linz Austria. Herzog expanded on the roof-leaf concept by incorporating an advanced light-transmitting roof that was first tested using scientific simulation techniques.

Renzo Piano also built upon this concept when he de-signed Menil Museum in Houston Texas. The roof-leaf system was composed of roof-panels' integrated within a plastic grid. This system introduced indirect luminous radiation from the northern hemisphere into the building. Conversely, during the summer months the system controlled excessive heat gain through a 16 mm deep retro-reflecting grid coated by a thin layer of aluminum, which prevents excessive heat from penetrating the building's internal spaces.

The roof leaf concept was subjected to numerous modeling and simulation studies involving a host of atmospheric conditions in order to develop and maximize a new roofing system that would facilitate and control light and solar energy. Likewise, the geometry of the plastic grid was determined by computer programs, while considering the angulations and elevations of the sun throughout the seasons. This was measured in relation to the orientation of the respective building, and slope of the roof.

CONCLUSION

Using scientific research in design demands that architects think more broadly and assume responsibility for developing building designs that are knowledge-driven. Knowledge should be used to ensure that a design is adaptable and integrative within its context as well as perform technically, contribute socially, and remain economically feasible. Architects must be cognizant of their design's impact on the physical and social environment. While architectural liability is governed by the individual states, the general standard is one of reasonable care. Specifically, individuals performing architectural and engineering services are performing professional services, and the law imposes upon such persons the duty to exercise a reasonable degree of skill and care, as determined by the degree of skill and are ordinarily employed by their respective professions under similar conditions and surrounding circumstances (Housing Authority, 1989). In essence, the standard is relative to other architects in the community. If the community standards change, then it follows that the standards for individual architects should change, although not necessarily immediately. Resulting changes in an architect's ordinary standard of care should be carefully considered before any major shift in design practice, but the use of scientific research, which brings with it the ability of the architect to use measurable outcomes to inform the final design, it is possibly the best defense in the event of a lawsuit.

The three case studies above illustrate a fundamental shift in the practice of architecture, by demonstrating how research methods can be incorporated into the design process. Each example shows that a design was conceived; it was then evaluated and subjected to a research method in order to enhance a performance objective for the building, and thus constructed. Admittedly, the examples are limited to natural day lighting and thermal conditions, but the process of crosschecking a design against sets of performance criteria is the same. Ideally, a building would have multiple performance criteria that include response patterns to climate and geography, the psychobiology of the human condition, and the capacity of the building to facilitate and be responsive to various information technologies. The design inquiry should lead to a design outcome derived from viable and performative criteria, which can then be measured and compared to alternatives. Kahn, Hertzog, and Grimshaw are only three examples of how architects have incorporated these kinds of measurable research methods into the creative design process.

In Kahn's summary of stages within the design process as a means of inquiry for "finding of form" exists a highly desirable model that embraces and incorporates scientific methods throughout the design process. However, many architects believe that an invisible dynamic within the evolution of architecture currently blurs Kahn's original expression. They believe that scientific and scholarly inquiry—phase two in Kahn's process—shapes the physical context of design away from the form-finding process. In actuality, the inception of a design idea is followed by a hypothesis or research objective from which a research methodology can be identified. The creative architect can develop a broadly defined performance agenda for his or her work and thus arrive at a series of performance objectives. These objectives can be used to support a range of assessment tools, which enable the architect to be better equipped with evaluative feedback. This feedback can then be used to guide subsequent designs. Such a comprehensive approach to design will yield optimum outcomes that promote productive and satisfying environments while limiting exposure to liability.

There is no doubt that a need exists for this new breed of architects who can design from a holistic knowledge base. To better prepare the next generation of architects to meet evolving trends, the role of the academe will need to foster intellectual growth by altering the existing culture of narrow definitions about the design process used by the profession to a much broader and holistic paradigm that includes research and research methods. The call today is to stand upon the shoulders of these giants and to incorporate research methods into the design process.

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A paradigm in architectural education: Kolb's Model and learning styles in studio pedagogy

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ABSTRACT:

In line with “learner-centered” teaching paradigm (Weimer 2002), enhancing learning experiences in design studio should be a fundamental concern positioned at the center of attention in current discourses of architectural education research. This focus warrants further studies on students’ cognitive patterns and learning processes to identify what goes in learners’ minds, and how learning style variations affect knowledge acquisition. In the applied and overlapping fields of architecture, urban design, and landscape architecture, drawing on cognitive studies and Kolb’s Experiential Learning Model have important implications for integrating and transferring learning in seminar/lectures to studio environments. Cognitive psychologists make distinctions between “declarative” recalling of factual knowledge and “procedural” knowledge of knowing to perform activities (Bruning, Schraw, and Ronning 2004:46-48). “Structural knowledge” is referred to “as internal connectedness, integrative understanding, or as conceptual knowledge” that “is used to develop procedural knowledge to solving domain problems,” involving the integration of declarative knowledge (Jonassen, Beissner, & Yacci 1993: 5). Kolb (1984) similarly describes how “learning is the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping experience and transforming it (Kolb 1984:41).” Various knowledge types are integral to learning in architectural education; thus, this paper proposes a course design model that investigates various knowledge implications. On the one hand, the studio environment, although productive and rich in learning experiences and professional opportunities, sometimes can be stressful, where teacher/peer pressures and competitive attitudes negate learning potential and lead to unproductive results. A one-semester long studio might not always offer the required time or space to learn procedural knowledge, for example, to solve complicated urban design problems, and in particular, to recognize multiple patterns affecting an urban/suburban context. However, lectures/seminars, on the other hand, usually attempt to convey significant declarative knowledge in one semester, sometimes without addressing actual application to studio projects. The objective of this paper is to propose a learner-centered pedagogical framework that applies Kolb’s Experiential Learning Model and integrates and foster significant interplay between the learning of *declarative knowledge* in theory classes and the *procedural knowledge* needed to solve design problems in studio environments.

CONFERENCE THEME: On Relevance: The interaction of allied disciplines in architecture and architectural education, are they doing anything?

KEYWORDS: architectural education, studio pedagogy, cognition, learning styles, Kolb’s Experiential Learning Cycle.

INTRODUCTION

This paper renders a learner-centered, integrative theory-studio pedagogy design that enhances cognitive learning processes, both declarative and procedural, by applying the four dimensions of David Kolb’s experiential learning Model (Kolb 1984). Cognitive psychologists make distinctions between declarative recalling of factual knowledge and procedural knowledge of knowing to perform activities (Bruning, Schraw, and Ronning 2004:46-48). The design based on Kolb is dynamic and multidimensional. It embraces Concrete Experience, Reflective Observation, Abstract Conceptualization, and Active Experimentation, which also contains multiple learning styles. By applying Kolb’s model to theory-studio design, the diverse learning styles of all learners are incorporated and a step-by-step course design framework enables studio and seminar design instructors to guide learners through each phase of the learning cycle. Additionally, the model further demonstrates how assessment of each type of knowledge and learning is embedded in the cognitive learning processes.

Original and evolving approaches to course development and syllabus design generate a relevant discourse within design education. The syllabus is an important element that impacts learning by structuring the course design and initial interactions with course materials. Moreover, it is a vehicle for teacher-learner communication throughout the semester. Therefore, to advance emerging design education in professional fields of architecture, landscape architecture, and urban design in the 21st century, it is essential to rethink course design and the syllabus as a critical aspect of improving design education. Together, these aspects should reflect the multidisciplinary nature of the fields and endorse the value of “design mentality.”

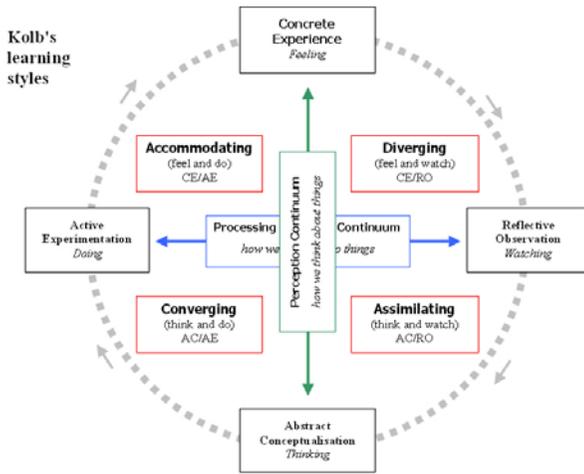
Students experience and interact with the course syllabus as a handout and preamble to the learning demands of a course. The syllabus should provide a clear roadmap, showing how overall course learning experiences are designed and set the stage for understanding all of the learning processes. It should be able to communicate the pathway students should take to achieve the course learning outcomes. A well-organized syllabus should also reflect an effective course design outlining session-by-session pedagogical strategies and learning processes. An effective syllabus and course design, therefore, can decrease learners’ many struggles and frustrations with not really knowing what they are supposed to do. It also cuts down confusion about activities, assignments and evaluation processes. An engaging syllabus that is well designed can increase learning enthusiasm while, however, without effective organization and clarity, it can deter interest, continuously affecting how learners proceed throughout the semester.

I- KOLB’S MODEL: RELEVANCE TO ARCHITECTURAL EDUCATION

David Kolb’s experiential learning theory is one of the repeatedly applied didactic theories in higher education. The Kolb’s theory is a four-staged learning cycle (Figure 1) that is broad enough to provide a base for the entire course as well as each individual course session or learning experience. Also, this cycle is democratic and diverse that can recognize various learning style. According to Kolb, this complete cycle needs to exist if the learning wants to take place entirely (Kolb 1984). Additionally, Kolb’s Cycle is inherently democratic and inclusive in its approach as each stage recognizes distinct learning style variations. Surprisingly, other than few instances, Kolb’s Cycle has less been appreciated and applied limitedly to architectural education and even more, specially, what is seen to be highly relevant, to the realm of design studio pedagogy. According to Kolb:

Learning is the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping experience and transforming it. (1984:41)

This paper is a prototype application of Kolb’s model to advanced, graduate level and integrative urban design seminar-studio courses for architecture majors. This paper will render, first, how integrating Kolb’s cognitive cycle of experiential processes into an urban design course, as a model of course design, leads to further enriching forms of knowledge, both declarative and procedural. Furthermore, in applying Kolb’s complete cycle, the diverse learning styles-- identified as “divergers, assimilators, convergers, or accommodators” are represented in the course design (Smith 2001, Threton & Walter 2009, Chapman 2006). Second, the paper will propose that the course syllabus can extend beyond the typical, and sometimes basic and confusing introduction to the course to become an influential learning medium. When constructed in alignment with the course design proposed, the syllabus can clearly communicate the instructor’s approach, instructional choices and serve as an effective medium to promote and enhance student learning. This paper as a whole is a theoretical effort. It demonstrates some of the ways in which instructor-learner transparency in communication, interaction, and expectations can be achieved. For example, well-thought, sophisticatedly designed course experiences and a clear, well-organized syllabus hand-out, in the first day of the class, can be an effective medium to inspire and promote learning.



© concept David Kolb, adaptation and design Alan Chapman 2005-06, based on Kolb's *Learning Styles*, 1984. Not to be sold or published. More free online training resources are at www.businessballs.com. Sole risk withdrawn.

Figure 1: (Image source: Kolb's Cycle's (1984) adaptation and design by Alan Chapman, 2006-05, accessed from website <http://www.businessballs.com/kolblearningstyles.htm>, date accessed December 20 2010.

1-1- MULTIDISCIPLINARY LITERATURES: LEARNING & KOLB'S APPLICATIONS

Considering the general popularity of Kolb's theory in higher education, a review of multidisciplinary literatures and its various applications reveals limited study of Kolb's model's potentials and promising applications to architectural education. For example, effort has been made to make concrete applications of Kolb in medical education (Armstrong & Parsa-Parsi 2005), engineering education (Abdulwahed & Nagy 2009), and geography (Healey & Jenkins 2000). In architectural education, few studies have partially rendered upon and investigated the role of experiential learning and pointed at Kolb's model (Schon 1984 & 1987, Demirbas & Demirkan 2003, Demirbas ?, Kvan & Yunyan 2005, Salama & Wilkinson 2007, & Sanoff 2007). Distinctly lacking is effort to develop a concrete, "learner-centered (Weimer 2002)" course model using Kolb's experiential learning theory in architectural education.

Despite minor concerns and criticisms with Kolb's theory, summarized at length (Oxendine, Robinson, & Wilson 2004:8), this study argues that Kolb's model serves as a practical and relevant framework, not only in the scholarship of architectural education, but also within the process of professional design practice. Kolb's experiential learning cycle parallels 'design thinking' and is keenly aligned with the broader patterns onto which architects and urban designers set about, select and design, their interventions in the built environment. Due to these strong similarities, Kolb's theory has potential application for participatory planning and design practice as well. For example, Wageningen UR Centre for Development Innovation has used Kolb's model to create a learning environment that encourages community participation in rural developments (<http://portals.wi.wur.nl/ppme/?Experiential%20Learning%20Cycle>).

Kolb's theory is highly adaptable to a general urban design process. Analogous to Kolb's step-by-step move through stages, a characteristic urban design process starts with a 'concrete' understanding of the built environment and urban context, or an existing spatial problem to be solved. It moves towards 'making decisions' in final design stages, typically, by means of theorization of alternative solution(s) and their 'abstract' realization through audio-visual media such as drawings, rendering, animations, maps, and images. Therefore, Kolb's sequential cycle can house the patterns that are associated with both design education and professional practice, starting with concrete experience and reflection, leading to action and intervention that is founded on abstraction and theorization.

I-2- DESIGN FOR THEORY AND APPLICATION: KOLB, LEARNING STYLES, AND TUTOR-LEARNER RELATIONS

Based on Kolb's Theory, Kvan and Yunyan (2005) studied the correlation of students' learning styles with their performance in architectural design studio. Demirbas and Demirkan (2003) evaluate the effects of learning style preferences on the performance of design students. They conclude that, amongst the students, there were significantly fewer "accommodators" and most were "assimilators" and convergers," moreover, they indicate significant differences in different stages of the design process between students' performances with different learning styles. In an analysis of Demirbas and Demirkan's study, Kvan and Yunyan conclude that:

...a design studio can encompass a wide range of learning styles if its programs start from ill-defined design problem, permit a range of communication media and are engaged over a relatively long duration, hence allowing more freedom in learning approaches... there is a significant correlation between learning style and students' academic performance in particular design studio.... (Kvan & Yunyan 2005:32)

The following studies are representative in addressing Kolb's experiential theory and the role of directed experience in design education. As Henry Sanoff puts it, *concrete* experiences or "field-experience approach to education" are valuable means for design learners to work with, complementing the *abstract*. This approach promotes "the use of non-formal, out-of-class experiences as the core of the learning process (Sanoff 2007:21)." As a way to integrate theory and practice in design education, Sanoff calls for "action-research" method as an integrated process starting with students' direct experience followed by data collection and observation about that experience, followed by data analyses and conclusions that "are fed back for reflection and modification (22)." Sanoff's "action-research" approach fit well with the Kolb's Cycle as well as the ways by which professionals in their real world practices go about designing buildings and urban places.

Other studies discuss multiple ways in which theory and its applications as design knowledge can be integrated into a learning setting that matches students' capabilities and learning styles. For example, Salama and Wilkinson's comprehensive study addresses cognitive styles in studio pedagogy and how learners acquire applied knowledge in design studio. The study refers to Kolb's "experience... followed by reflection" as an effective approach (Salama and Wilkinson 2007:187), and categorizes "three polar types of styles" of *sequential-holistic*, *convergent-divergent*, and *impulsive-reflective*. They argue that students should become aware of their preferred styles and be able to switch from one to other when needed (189-190).

"Thinking globally and acting locally, reconciling lectures and studios, and addressing cognitive styles in studio pedagogy" are viewed as three significant approaches to students' semantic knowledge development (188). These contribute to an enhanced learning on creating solutions for concrete places and particular cultures, responding to specific environmental problems and social structures, working with communities and dealing with practical realities, while, at the same time, respecting the order of the physical setting, and providing room for cultural expressions and cultural variations. The study also renders on the 'emotional stress' that is facing students in this process. The authors define cognitive styles as individuals' "aptitude, abilities, attitudes, and working styles." The importance of these should be "identified and made transparent to the students in order to increase the effectiveness of their education" (189)." They conclude:

Design educators should be able to provide their students with fundamental and ethical knowledge through which they can see beyond their own space, time, and culture, and understand the larger structures and processes of human habitation. ...

This concept can be addressed in studio pedagogy by introducing problems that aim at studying the characteristics of different societies, social classes, and the contextual particularities of different regions (188).

The studio environment, besides being productive and rich in learning experiences and professional opportunities, can sometimes become stressful, where teacher/peer pressures and competitive attitudes negate learning potentials and lead to less fertile results. Few studies have focused on student "lived learning experiences" in design studio as well as the tutor-student relationships in studio pedagogy (Webster 2003 & McLaren 1999). The studies distinguish "liminal servant" as the alternative tutoring paradigm and an "ideal" role for the design tutor in one-to-one tutorials.

Webster's qualitative study considers "project-based learning" to be at the kernel of the pedagogic tools in architectural education. Besides the required and ongoing students' need for 'critical reflection' on their work, satisfactory one-to-one tutoring is also significant in this learning process. The ethnographic research findings conclude that students usually experience three major types of tutor behavior: "the entertainer, hegemonic overlord, and liminal servant." Amongst the three, only "liminal servants," as described by McLaren (McLaren 1999:128), increase the learners' impetus that will support resourceful learning. McLaren defines 'liminal servant' as:

...a tutor who is interested in assisting the learner to construct their own knowledge (deep learning) through addressing both the cognitive (scaffolding) and social (the underlying belief systems - values, norms, behaviors - implicit in the disciplinary area) dimensions of learning. The 'liminal servant' adopts a student centered approach to the role of tutor by assisting the student to manage and construct his or her own learning through critically reflective dialogue (Webster 2003:109).

Unlike "entertainers" and "hegemonic overlords," "liminal servants" neither are propagandists for a certain architectural culture or style, nor coercive ideologues. They practice two-way communication and a mutuality that understands students' frustration and challenges in studio life. They compassionately allow expressing those frustration and discomfort, and always give students advice and assistance. By enthusiastically engaging with every student ideas, they make them also enthusiastic about their own learning. Transparency of roles, responsibilities, and requirements are also important in this relationship (Webster 2003).

In addition to differences in learning styles, design education should also recognize students' "prior knowledge" and experiences as well as cultural backgrounds in order to promote deep transformative learning. Mainly, by an insider understanding of the students' problems from their perspectives, and by accepting individualistic differences of ideas and learning styles, and helping to develop them, the alternative tutoring attitude is further democratic, better sharing power in class. Design educators should become democratic facilitators who offer design guidance to help students to consciously construct their own learning experiences and assist them to manage and plan for their studio work as well as future design career.

1-3- SEMINAR AND STUDIO PEDAGOGY: SYLLABUS AND COURSE DESIGN

In addition to a critical review of literatures associated with higher education, architectural education, and Kolb's theory, numerous architectural, landscape architectural and urban design studio and seminar/lecture course syllabi have been examined and compared. The aim was to investigate a general ambiance of how much intentionality and creativity goes into putting them together as effective, well-organized, and communicative learning medium. Based on the extensive evaluation, this study wraps up that a commonly recognized pattern amongst them all is that: *only* few seem to be able to thoroughly communicate with students a clear definition of the expected learning experiences and processes that are decisively designed into the course (Figure 2 & 3 show two divergent examples).



Figure 2: This syllabus image, intentionally made illegible, is a generic example of a linear syllabus that is typical of many seminar/studio syllabi found in architecture, urban design and landscape architecture that, often, lacks an easily decipherable and cognizant schema.

Many of the investigated syllabi were 'linear' in narrative, making it difficult to communicate with (Figure 2). Many were also taking further rigid approaches in describing the course itself, the goals and expectations. They were mere indications of important due dates, objective grading criteria on percentage scale, and thickly loaded reading contents. Only a small number of the reviewed syllabi were crafted intentionally with a design that is transparent enough to explicitly communicate the course learning experiences, bit by bit, throughout the semester (Figure 3).

Although this study is NOT making the general claim that linearly-organized syllabus is direct indicative and evidence of instructor's lower performance quality, the syllabus is certainly an important course design element. It is not fully possible to evaluate general success or failure of a course or an instructor's performance merely through the syllabus. However, a well-designed syllabus can be the primary creative space that is reflective of instructors' teaching abilities. Teachers can assume, in their syllabus, they have made their expectations and demands from students fully transparent and clear, but this may not be their right assumption. If their higher expectations were not as clear as they think, students would get more confused and this state of confusion would, to a great extent, diminish their learning efficiency.

Students are often expected to take care of every piece in their studio projects: display paramount design skills, produce inspiring design outcomes, pay decent attention to design process, practicality, and pragmatics of their design solutions, and at the end, bring to the table the highest quality and creative final presentation products. In this case, more work should be done in the part of instructors' responsibility to prepare the grounds for such demands. Therefore, this study invites the realm of design education to rethink the approaches to curriculum design in order to make "projected" or

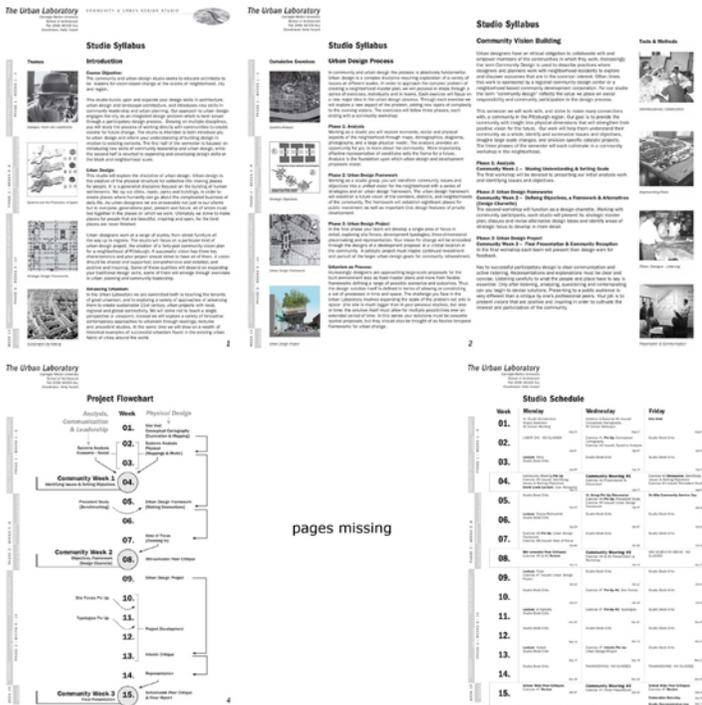


Figure 3: This image shows a less-linear syllabus pattern that can represent a stronger, more communicative approach to curriculum design. Such a syllabus has a 'rhizomatic' schema, the inventive thresholds and openings to new concepts that can visibly convey how, in the course of the semester, the 'learning' would take place.

(Image source: "The Urban Laboratory" studio syllabus, Coordinated by Kelly Hutzell, retrieved from http://www.cmu.edu/rci/images/ulsyllabus_08.pdf)

expected learning, along with the course experiences and outcomes, further translucent to students from the course beginning. Innovative approaches are needed to make the syllabus clear enough for it to be able to reflect the course journey as a whole and act as students' initial and effective roadmap towards learning.

1-4- ENHANCING APPLICATION AND HIGHER LEARNING: PRIOR KNOWLEDGE, METACOGNITION, AND CONCEPTUAL SCHEMA

"Prior knowledge" is an essential element to be not only considered, but also guided and integrated into the learning experiences of any course, architectural education lecture and design courses not excluded. Students enter every classroom or studio setting with misconceptions, existing knowledge, and different ways of looking at the built environment and approaches to studio projects. In other words, design and theory problem-solving tasks require them to apply and enhance their preceding skills and abilities. Therefore, "new knowledge" should always be aware to be built upon "existing knowledge." Instructors should also consider learners' partial understandings, counterfeit beliefs and misconceptions, or those not-yet-mastered skills and naïve interpretations of the course concepts. The "science of learning" elaborated by Bransford et al lend resourceful insights to this aspect of the study (Bransford, Brown, & Cocking 1992). Bransford et al emphasize on key aspects such as "expert understanding," and transferable and "useable knowledge (9)." The insights from their study can further enrich this exemplar curriculum design case. The authors argue that teachers should pay attention to students' interpretations and endow them with guidance when necessary:

...Learning is enhanced when teachers pay attention to the knowledge and beliefs that learners bring to a learning task, use this knowledge as a starting point for new instruction and monitor students' changing conceptions as instruction proceeds (11).

...Students come to the classroom with preconceptions about how the world works. If their initial understanding is not engaged, they may fail to grasp the new concepts and information that are taught, or they may learn them for purposes of a test but revert to their preconceptions outside the classroom (15).

This integrated course and syllabus design exemplar takes a metacognitive approach to instruction in architectural education. This model provides an intelligible framework, a clear "schema" and semantic knowledge that can, visually and perceptively, "chunk" course learning experiences and make the course elements lucid to learners. This actually embodied version of the Kolb's theory is particularly beneficial in teaching urban design topics that are further complex and multidimensional, and contextually sophisticated. This curriculum theorizes to connect design education to the expert metacognitive models that take the active-learning and "meta-cognitive" approach to instruction rendered by Bransford et al (Bransford, Brown, & Cocking 1992:12). They help learners "take control of their own learning" and giving them a meta-cognitive image tool to actively predict their performance and consciously monitor their progress (18). They also generate sociable learning environments in both classrooms and studio settings. Such spaces enable mutual negotiations on the learning process and a "share of power" with students. The meta-cognitive approach to instruction and syllabus design not only enhances a vigorous transfer of knowledge, but also increases the degree to which learners, without the need for explicit prompting, can transfer theoretical application and design methodology to new situations, contexts, and problems. In addition, based on Kolb's theory, the modeled courses in this paper use multimodal combinations of both "hands-on" teaching techniques, such as inquiry and project based learning experiences, case and precedent studies, and modeling and simulations, as well as "minds-on" moments, like lectures, critical thinking, and reflective experiences.

2- URBAN DESIGN EDUCATION: COURSE DESIGN FOR AN ILL-STRUCTURED DOMAIN

This study approaches the disciplines of architecture, urban design, and landscape architecture as nonlinear and "ill-structured" domains. Therefore, architectural education and design problem-solving differ from well-structured linear disciplines such as the sciences or engineering. An "ill-structured knowledge domain is defined as one that has the following characteristics:

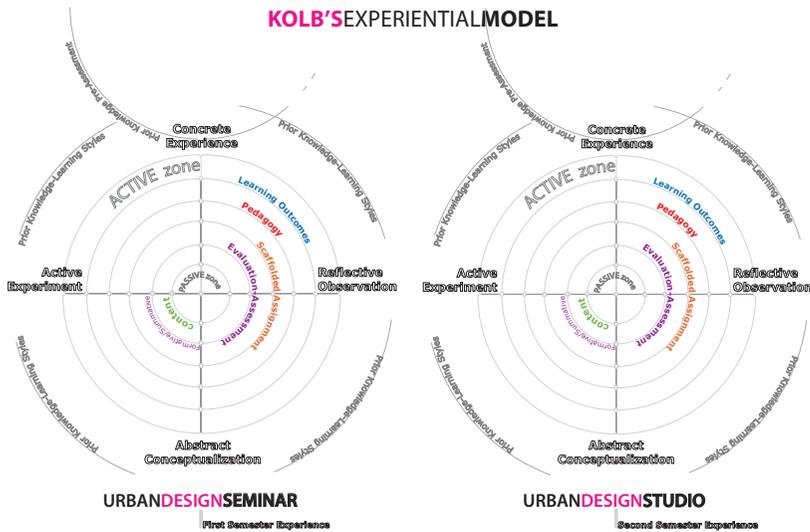


Figure 4: The figures show multiple important elements considered in this integrative course design experience. The subsequent figures in the paper will expansively delve into the courses' details on these main elements and show how 'prior knowledge' is resourcefully engaged and how various learning styles are accommodated in course activities, assignments, and discussion. (Source: author 2010)

- (1) Each case or example of knowledge application typically involves the simultaneous interactive involvement of multiple, wide-application conceptual structures (multiple schemas, perspectives, organizational principles, and so on)... and (2) the pattern of conceptual incidence and interaction varies substantially across cases nominally of the same type ... (Feltovich, Jacobson, & Coulson 1995: 92).

In "ill-structured" fields, "learner-centered (Weimer 2002)" instruction, including course development and syllabus design, should reflect the non-linear nature of the field. The course designs and syllabus are the first learning environments and elements students encounter. They serve as the initial steps and blueprints for future achievements, increasing their importance and the value of interactive designs, rhizomatic with multiple sophisticated connections to multidisciplinary knowledge and global perspectives. Sylvie Richards (2003) describes an interactive syllabus as a "learner-manipulated environment" wherein "concepts are presented in different ways and at different times" that result in "multiple and adaptive interpretations necessary for knowledge acquisition (Richards 2003:1)."

2-1- A MERGED PLATFORM: URBAN DESIGN CURRICULUM BASED ON KOLB'S MODEL

This section provides a concrete and cognizant syllabus framework adaptable to multidisciplinary and broad-scoped urban landscape design project topics. The merging platform of this combined seminar-studio is unique given that its experiences are backed up theoretically by being designed into Kolb's model (Kolb 1984). The course model explores how Kolb's experiential learning and its cognitive processes are "learner-centered" concepts that can accommodate various learning styles and enhance studio learning (Figure 4).

As illustrated in Figure 4, the two integrated courses are designed in a way to engage students in both 'active' and 'passive' modes of learning, when appropriate, by using a mixture of both 'hands-on' and 'minds-on' experiences. This adaptation of Kolb for urban design education also emphasizes 'Prior Knowledge' as an important element to be acutely considered and planned for in juxtaposition with the course learning. It is advantageous to assess students' earlier knowledge on methods, theories, and design approach in the beginning of the course. It is also helpful to organize a Learning Style Inventory prior or within the first session in order to identify students' learning preferences.

A students' transparent understanding of a course process through the syllabus can improve learning by justifying why the tutors do what they do and rationalizing the ways in which they do it. Knowledge acquisition in design studio can predominantly occur via transformation of student experiences as they are consciously constructing their own approach to learning. This transformation, as Ramsdan argues, should happen "as a process of working co-operatively with learners to help them to change their understanding (Ramsden 1992:114)."

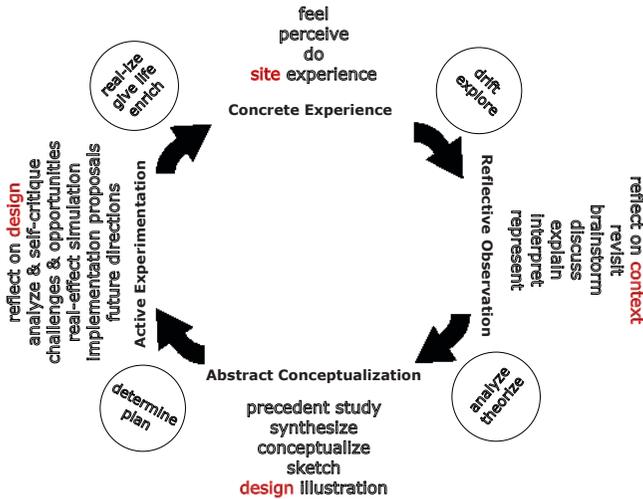
2-2- A COURSE DESIGN COMPREHENSIVE MODEL

The framework offered in this paper provides one application of Kolb's theory to design education. The following (Figure 6 & 7) comprehensive illustration of the two design courses, seminar and studio, accompanied by detailed information regarding the important course design elements: syllabus, pedagogy and activities, learning outcomes, scaffolded assignments and formative and summative assessment techniques. This model visually communicates how all of the course elements and research-based principles of learning are integrated. Useful for teacher and student, this visual portrayal of the course design increases transparency and clarified the processes both embedded and expected that lead to deeper quality learning. Research shows that one of the most discussed frustrations of architectural design students, in particular, within the studio setting, is the insufficiency or lack of advance, step-by-step knowledge that informs them about what should be done next, how to proceed, and what they should achieve by the end.

This paper argues that an explicit and transparent integration of Kolb's cycle into the course design can make the learning process clearer, more meaningful, cognizant, and perceptible for students. This improved meta-cognitive gain is highly indicative of increased transfer and application (Bransford 2000). In addition, this model of an integrated theory-design course supports building on prior learning to more advance and expert learning (Bransford 2000). Just as important, intentionally integrating the earlier seminar course learning into the studio reduces the time required on reading and making sense of the earlier abstract concepts and the theoretical foundation once inside the studio. Hence, more effective and productive time can be spent on the actual applications and implications of the previously learnt concepts. Within the Project-Based studio structure, Kolb's theory flexibly houses diverse instructional activities. Design projects can be defined based on both "accessible" and "remote" site type projects and a variety of relevant pedagogical strategies can be utilized to further advance the experiential learning experience (Figure 5).

In the course structure, the syllabus is the initial learning environment encountered by students and serves as an interactive instructional roadmap designed to maximize learning. The course design communicated in the syllabus through alignment with core teaching and learning philosophies and principles, can further emphasize deep, quality learning, active and interactive learning environments, and increase the transparency of learning processes, roles, and expectations. Furthermore, the subject matter of urban design by nature is complex, multidimensional, and open to interpretation. This nonlinear and ill-defined aspect of urban design must, therefore, translate into the course design and delivery in a way that engages the design of course content, materials, activities, and learning processes. The Kolb's Experiential Learning Model is the theoretical framework designed into this course syllabus and activities. According to David Kolb, a cycle of four processes must be present so that learning occurs most completely (1984). The course learning prompts and encourages critical thinking, challenging students to explore thematic questions such as: How would you design if your access to an urban environment and its people was geographically remote. How would you approach design differently/similarly if your admission to the understanding of a city and perception of its urban experiences could NOT be on-site and real, for instance, if it is challenged by socio-political isolations or natural or man-made disasters? What different means and resources would you use to glean "concrete" familiarity with the site, and what specific genres of representation would you draw on to communicate your ideas and ultimately guide decision and action?

The Urban Design studio complements theoretical learning of the preceding seminar titled "Didactics of Public Space and Urban Landscape: Reflection on Theory and Implication for Design." The studio centers on innovative approaches to the experience, analysis and design of socially sustainable urban public spaces. Place-making for people is the central theme. Although the realm of exploration



PROJECT-BASED STUDIO ORGANIZATION
STUDIO INSTRUCTIONAL ACTIVITY CYCLE

Project Types: Accessible vs. Remote

Figure 5: This figure shows how various instructional activities can be adopted into the studio's learning experiences based on Kolb. In a Project-Based urban design studio format, assigning two different types of project topics are possible: either ACCESSIBLE, on a national or local scale, or REMOTE or inaccessible, on an international scale. Because the earlier seminar course learning is integrated into the studio, a reduced time is spent in the studio to read and make sense of abstract theoretical foundation. Therefore, more time can be spent on actual applying and exploring the implications of the previously learned concepts. (Source: author 2010)

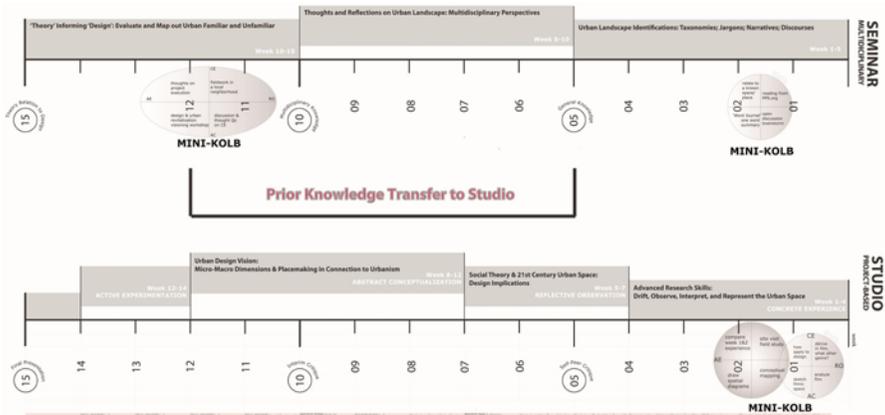


Figure 6: This experientially-rich, dynamic, and multidisciplinary studio course syllabus, developed based on Kolb's model, is coupled with the previous knowledge from the seminar to enhance students' learning. In addition, the 'prior knowledge' transfer is an essential design element. The design course is divided into four sections according to the Kolb's four pieces in the cycle. Kolb's experiential cycle provides a flexible tool for any pedagogy design. This holistic figure shows how Kolb's model can not only be integrated into the whole course learning experience, but also "Mini-Kolbs" can be designed into each session's (e.g. session 2 of the seminar in Figure 7) OR a combination of sessions' (e.g. sessions 10-13 of the seminar) learning activities. A note here is that a bigger scale course design poster, provided during the paper presentation session at ARCC 2011, gives a closer look at the design details. (Source: author 2010)

STUDIO PROJECT-BASED

Advanced Research Skills: Drift, Observe, Interpret, and Represent the Urban Space

Week 1-4
CONCRETE EXPERIENCE

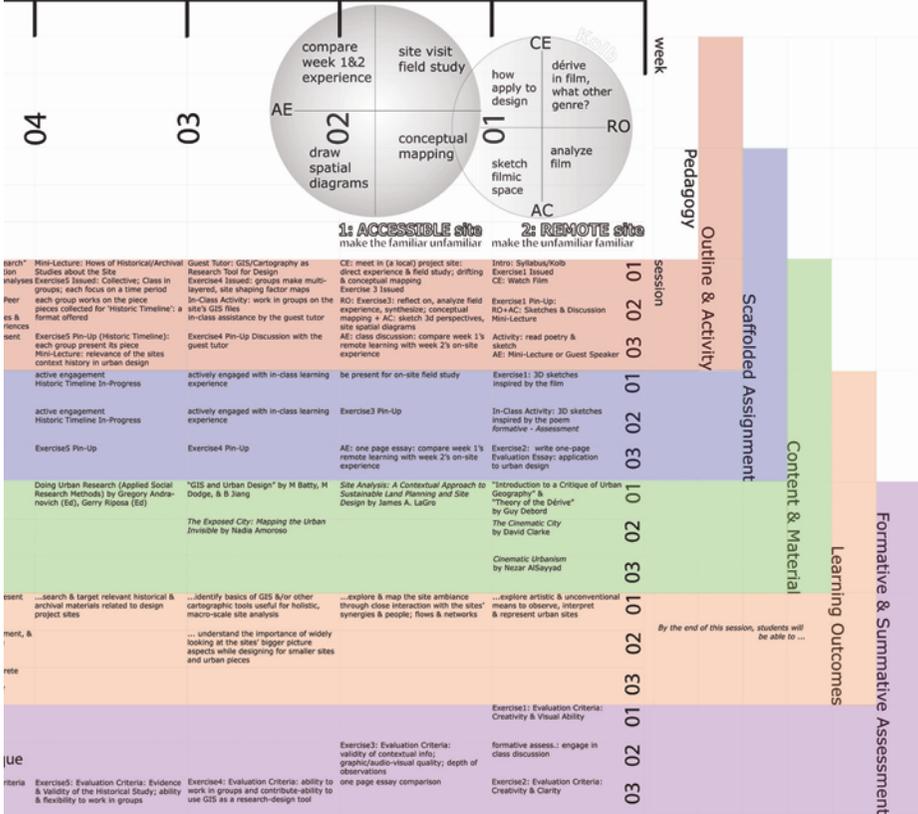


Figure 8: To show the flexibility of Kolb’s model, studio sessions one and two looks at how the model can be appropriated for an urban design project with a “remote site” or one with an “accessible, local site.” (Source: author 2010)

EPILOGUE

For a 21st century architectural education, changes in design teaching culture is needed to match pace with other societal and cultural learning transformations. Design pedagogy is a cognitive as well as physical process for which design studio is the main forum. To enhance learning experiences and better educate the future designer, opportunistic inquiries should emerge that investigate innovative approaches to course and syllabus design. Therefore, multidisciplinary cognitive frameworks should be applied to bridge the two interdisciplinary domains of ‘education’ and ‘architecture.’ As Salama and Wilkinson argue:

Despite the tremendous changes in all aspects of life including architecture and urbanization, the current approach of teaching design continues to follow principles, rules, and practices developed in

the past where the influence of Beaux-Arts and Bauhaus models is still dramatic. Research indicates that designers in the academia will distance themselves from the real worlds, still barricade themselves from real human problems, while missing the opportunity to learn from the richness and depth of human experience (Salama & Wilkinson 2007: 4).

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SEAty_ living beyond the waterfront dynamics outcomes and risk of a new trend

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ABSTRACT:

The growing number of projects for floating structures or artificial islands in response to the problems of urban congestion or environmental emergency requires a critical reflection on the perspectives and the risks implied in this new trend of urban water colonization. This paper intends to test the hypothesis that the value of a new and emerging issue of Architecture can be recognized to this trend and, through a comparison with a series of experiences, wants to bring to the attention of the debate a number of questions which, for exigency of synthesis, analyze in particular the morpholinguistic issues related to the diffusion of this new architecture theme.

CONFERENCE THEME: Identifying or assessing emerging trends and fields in architectural research

KEYWORDS: waterscape; colonization; fluid; environment; mimetic language

INTRODUCTION

“non in terra neque in aqua sumus viventes”

trad. “not in the land nor in the water, we are living”

Paolo Diacono (720-790 d.C.), describing the high water of Venice.

The issue of the requalification of the *waterfront* has deeply characterized the debate on the urban project in the last ten years, allowing to investigate the capability of the architecture project as instrument of regeneration of these areas once dismissed, but charged of identity-making and landscape values to resemantize.

The experiences of London, Bilbao, New York, Boston, Genoa, Valencia, Buenos Aires, Barcelona, Rotterdam, Oslo, Hong Kong, etc., demonstrate the consistency with which these processes of urban regeneration in coastal areas will spread like a virus positive and fruitful. In recent years, is to establish that what Prof. Rinio Bruttomesso, president of Cities on Water defines the process of “*Global waterfront renaissance*”.

The *Global Waterfront Renaissance*, is explained as the ancestral need to seek water. Water is our most important resource of life. Equally it is natural for defining and ecological events, as it is for regional economic and social structures. The smell of the sea, the sound of a river and the infinite dimension of the ocean are the aspects that make unique and extraordinary the places on or near water.

In the contemporary cities, from the vestiges of big urban port systems in abandonment, always more often, new parts of city rise, that use the heritage of this huge *reservoir* of free soil, introducing new functions compatible and coherent with the presence of water. The number of case studies, of the realizations, the amount of theoretical studies and the researches on the theme of the *waterfront*, begin to configure it as a new rhetoric figure of the urban *logos*. Today, a new, and in part, dangerous trend seems to affirm itself with global diffusion. A trend that aims to expand the urban boundaries *beyond the waterfront*, through a progressive colonization of the water. The Burj al Arab, the sail skyscraper of Dubai, now definitely become a *kitsch* icon of unbridled and inappropriate luxury; the OMA project for an artificial island in Azerbaijan; the futuristic utopias of floating cities for a million of inhabitants in *Vincent Calabaut*; but also the airport of Kansai of Renzo Piano or the project for an off-shore port of BIG architects and the floating neighborhoods so widespread in the United States and the northern Europe, are just some of the cases that define a new scenario in

evolution that requires an interdisciplinary reflection and that, for the architects, opens the field to ethic, morphological, typological and linguistic considerations of great conceptual importance. Most of these projects, in fact, regardless of whether they are designed as floating structures or artificial islands, don't use the water as a proper material of the architecture or as an element of the traditional *solid-liquid* dialectic, but rather as a *new territory* to which they refer often in mimetic terms. The water becomes the nature from which to draw specific formal references to reuse as linguistic elements. This process of *invasion* of the boundaries of what could be described as the *liquid territory* happens under the pressure of two main motivations.

The first of the reasons for this *invasion* has to be searched in the growing need of spaces for the already congested coastal metropolis that find an unique opportunity in the space offered by the immensity of the sea to give space to new needs (more or less necessary) and functions mostly related to the big infrastructures (ports, airports, sports facilities) or the luxury residentiality¹.

A second reason, of more utopian and futuristic matrix is linked to motivations of environmental nature particularly related to the catastrophic paradigm which provides that the expected rise in the average sea level will lead to a gradual abandonment of coastal areas with the consequent need to find space for the populations settled in these².

These two motivations, also if anticipating the same result of a partial but progressive colonization of the *liquid continent*, seem inspired by deeply antithetical inspirations.

If, in fact, the first is based on the desire to give response to a purely utilitarian and speculative request or to proceed to the growth of the already immense coastal megalopolis; for contrast the second is connoted with strong characters inspired to the social utopia of environmental brand aimed to rescue from the expectation of continuous floods and the progressive sea level rise, that humanity, whose disregard towards the natural balances has led to this state of perpetual environmental emergency.

In this case, these projects of *see colonization*, water can be ascribed to the area of environmental design at least according with the definition given by Maldonado that is:



Figure 1: Kansai Airport, (www.pref.osaka.jp)

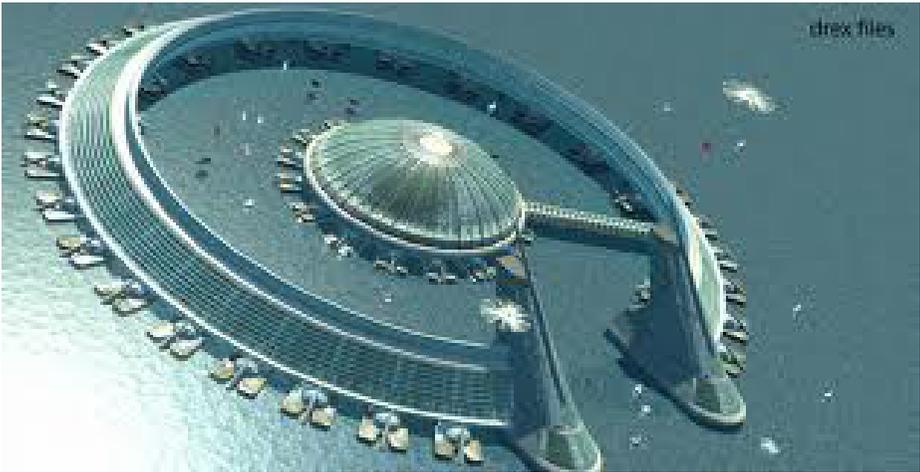


Figure 2: The Venus Project of Jaque Fresco (www.thevenusproject.com)

“that practice aimed to the environment preservation, that is, to the problems relative to the process of its adaptation to the mutable exigencies of the society and to the resources management.” (Maldonado,1970,15)

The ancestral attractive ability of the water and its relationship with the architecture of the cities reconfirm a constitutive, and full of theoretic and conceptua ideas, archetype. A certain aquatic architecture seems deeply inspired by the “*things of water*” to which it is assigned a force enduring and immortal, an objective and eternal functionality whose spirit, almost as a guarantee of coherency and adaptation to the surrounding landscape, is introjected into the project. So the aquatic landscape becomes the world to which making reference in imitative, almost mimetic terms. The city of Venice or that of Bangkok, the myth of Atlantis, but also the archetype of the piling, demonstrate how the issue of the water colonization has obliquely crossed the human history and how today, at the light of the considerations made, once again it becomes an issue endowed with its specific autonomy.

Although it may seem premature and apodictic to assert it, against the consolidated culture of the city that has, especially in the last four decades, generated a wealth of critical approaches and realizations of architectures that draw their same sense from the urban *logos* - and not naturally for a mere reduction of scale - so it can be affirmed that, under the new trend of *sea-colonization*, a new area of architectural attention is gradually consolidating, an approach with a strong brand identity in the architectures that aim to *recognize* the water in the measure in which they pervert it with the introduction of infrastructural or residential functions.

In this sense it manifests itself a world of iconographic references, a collection of emphatic and rhetoric figures all equivocally inspired and sometimes truly obsequious toward the aquatic spirit or the world to this directly connected in terms both of utility (ships, boats, sails, etc.) and abstraction (islands, wave motion, wind, etc).

It is possible to affirm that this *incongruous list* (the hulls, the waves, the sails, the wind, the marine ani-mals, the anchors, the cranes, the gangways, the large scale of Le Corbusier’s steamship, as well as that of the small boat) disordered and friendly to the place, perhaps for the same novelty constituted by the attention that the contemporary directs to the aquatic landscape, is going to recognize a corresponding list of possible metaphors, which propose themselves as durable for a long period of time. In this way, in the recent experience of the aquatic architectures the risk of homologation reveals itself, which coincides with an impoverishment of what Freud defined “the *overdeterminations* and the *condensations of the expressive forms*”, many of these recent examples appear, that is, to satisfy - giving up the intrinsic valence of the architecture to be polysemic - an unique meaning, beyond that dependent on their function and corresponding with the desire to reveal their *appertaining* to a particular context. As the dialogue that the project establishes with the place is always based on

a legitimacy of its existence, this must not lead to a process of deduction from the context of the elements structuring the route and design outcomes. On the contrary it could be argued that the quality of the project is measure of the critical *distance* that we are able to establish with the context. However the rhetoric aquatic figures with archetypal connotation, justifiably limited in number, will not mean, for the procedural status of the design process, a limitation in the variety of their architectural declinations.

So this *limitatio*, that does not always lead to a *concinmitas*, makes to rise the possible figures to the dignity of *type*, as it has often happened in the history of architecture: an art that has in the articulation of the combinations, in their *composition*, rather than in the invention of the elements to combine its primary methodological foundation.

Here's how the universe of the architecture of water colonization appears as a field of preferential conceptual experimentation to investigate those relationships between project and context that others places have developed for longer time and with greater wealth of experience.

“Designing and constructing a building means producing an intersection between the willingness of the artifact of self-determinating, to grow up free from any conditioning as if it was built in an absolute vacuum, and the opposite tension towards its becoming final concretion of a historical process of construction of part of the world, as result of that long layering of tracks, tissues and monuments that has given form to a place.” (Purini, 2005.189)

Trusting in *Purini's* intuition, which sees an armistitial relationship between the internal tensions of an architecture that wants to be thing and the conditioning of a context that brings it back to *sing in chorus* with other consolidated elements of the landscape, it seems legitimate to extend the criticality of this practice to the port context, however highlighting some probable peculiarities.

It is legitimate to argue that the list and the historical stratification of the elements that limit the figural autonomy of the projects for these architectures, is both in number and density smaller respect to the traditional urban context.

I. LEARNING FROM WATER:

THE SPASMODIC RESEARCH OF ADEQUATENESS TO THE CONTEST

“In the word form is implicit, among other things, an ambiguity of meaning that is useful to highlight. The architectural form of a phenomenon is in fact on one side the manner in which the parties and the layers are arranged in the thing, but at the same time the power of communication of that disposition. These two aspects are always co-present, but, while there is anything without form, the form has powers of esthetic communication disposed on very differentiated levels.

It could be called form the first aspect and figure the second; the value of figure is never intended as zero; we can always recognize its tracks even if at the level of extreme deterioration. Therefore, it is beginning from the figure that the sense of the phenomenon is traceable, reconstructable its totality, the plurality of its constitutive elements, of its proposals.” (Gregotti 1966.54)

Vittorio Gregotti in this reflection, from his most famous writing on theory of architectural design, *Il Territorio dell'architettura*, puts, with extreme clarity and efficiency, the question of the complex relationship that the discipline creates with the world of the form and how this establishes continuously, in a way more or less direct, more or less conscious, a relationship with a figure. In particular Gregotti makes to coincide with the figure the potential of esthetic communication of an architecture work, giving to this latter a valence of psychological nature even before than an objective one. The figure is for Gregotti the elementary unit of the project; to this he gives the value of sense of the total architectural organism, to this the role to bring back into a synthetic unity the whole complexity of the architectural phenomenon.

In the *aquatic landscape*, the figurative characterization of the form of the architectures appears in many cases as a process that allows an immediate decoding.

In the substantial landscape uniformity of the water, which repeats its landscape, in a widespread and undifferentiated way, one can trace the continuous repetition of architectural forms that appear all inspired by the same figures.

In this continuous reiteration, we identify the formal principle of the *consonance*, which defines the first and most characterizing of the two extremes within which the formal poetics of the *architectures on the water* oscillate.

The second extreme can be identified, for counterpoint, in the dissonance intended, in this case, as the presence, in the architectural forms, of a substantial figurative indifference, respect to the context, more extensively the apparent absence of a connotative willingness, in the meaning in which the term appears, as already explicated, it constitutes a potential of esthetic connotation.

Even from a brief survey on the most recent production of *aquatic* architectures, offered by the sector advertising industry, it seems indeed that these, whatever their type, intend to answer *in primis* to a desire of *appropriateness* of the context. Appropriateness to the surrounding liquid landscape, precisely *consonance*. "The architecture is construction of an adequate real space, which evokes visually the appropriateness" (Lukacs, 1960.33). These architectures, three-dimensional set of the most recent works of water colonization, seem constantly to run after the adequateness to the context. In these terms the position of Lukacs proposes an own attitude of these architectures, which seem to arise inspired by a principle of coherence, which is not showed, with equal insistence, in other contexts recognized and circumscribed.

By virtue of their *aptitude to the adequateness* all enjoy a principal *immediate evocative value*, in these we recognize, as the children do with the clouds, familiar figures, by reducing the complexity of the forms to iconisms of the aquatic figures.

The iconic power of the forms of marine and industrial landscape almost rediscovered and appreciated since the beginning of the Modern Movement, made Le Corbusier to express himself so in *Towards an Architecture*:

"The architects live in the poverty of the school education, in the ignorance of the new constructive rules, and their concepts are happy to stop to the doves that kiss each other. But the bold and wise constructors of steamers, create buildings near which the cathedrals are all small, and throw them into the water!

Anonymous engineers, mechanics at work between the mold and the fat of the workshop, have designed and built formidable things like steamers. We are terrestrial unable to appreciate, and it would be nice that was given us the opportunity to do the miles of distance corresponding to the sight of a steamer, to teach us to admire the work of the "regeneration".

(Le Corbusier, 1923)

So it happens that some architectures, built near water, define their form from a circumstantiated world whose main figurative references are made not only by the natural elements connoting a neighborhood, already present and available and elevated to the paradigm of modernity for their absence of figurative intention.

This spasmodic research for *adequateness* of the architectural forms to the marine environments, or in general to the aquatic ones, is not immune from the risks of ephemeral redundancy. In fact, where this redundancy, rather than by a critical revision of the figures of the aquatic landscape, is led by a *mimetic process*, which aims exclusively at the research of a mere formal homologation of the new architecture to the context, it happens that the boundaries of a self-referential *aquatic mannerism* appear.

A mannerism that makes to decay the *form* reducing it to its most immediate and exterior condition of *image*. Against an ephemeral conception of architecture Vittorio Gregotti recalls to a *critical realism* as an interpretative filter to put against an esthetic communicative meaning of the discipline:

"It does not move (the critical realism e.n.) - Gregotti writes - against the imagination, but against its ideologization, that is against the image as representation of the market show, against its attempt to reduce the architecture to image, to theatricalizing event, to incessant novelty, to imitation of multimedia, that is, once again, at the total dependence from instruments became purposes" (Gregotti, 2005.36).

In few other contexts like these, the contemporary designers want particularly to make understand that they are aware of working in a certain context: that is, they shrink away from a disciplinary research based on the tradition of history, to encourage a much more reassuring mannerism, at the

point to reconcile us, recognizing it how profoundly true, with a possible peculiar paraphrase of Celine's famous aphorism that wanted to be the only view of the sea *evocative, for the bourgeois, of deep thoughts*.

The *formativity process* (Pareyson 1988), that enables the design approach in these contexts, seems to be inspired by a single common mind.

As it happens in the colonial territories, in which the characters of the motherland are emphasized for a longer time than in the same mother country, after that they have already set in this and considered provincial residues, so it will happen, perhaps still for many years, until the exhaustion of the phenomenon that we analyze, that the aquatic architectures will tend to exasperate their aquatic features.

This design approach can be assimilate to the transference induced by a sense of guilt that directs the forms to take on the features more specifically aquatic, almost to redeem themselves for the introduction of extraneous activities.

2 CONSONANCE AND MIMESIS AS

LINGUISTIC PRETEXTS

These architectures on water put themselves with regard to their context in an attitude of *mimesis*, as well as it is intended, in the meaning introduced by Auerbach, of *represented reality rather than representation of reality*.

Auerbach introduces the concept of mimesis as the tension to a realism intended as "*willingness to observe theoretically the earthly life*." Where to the ad-verb *theoretically*, the author matches the idea of an interpretative act of the constitutive elements of the reality, intended as such. The architecture of the *consonance*, also of that which takes place in areas near the water surface, seems to refer to this concept of mimesis: it is an interpretative act of the reality of the landscape that surrounds it. This reading is approached following two main categories of *emulation*. A *mimesis* of functionalistic type: architectures that *imitate* the machines produced by humans to challenge the waters, and a *mimesis* of organic type: architectures that imitate the natural elements drawn from the reality of the sea, such as its liquidity, the movement of the waves, the blow of the wind, animals and sea monsters. The compliance, more or less conscious to formal consonances proper of the aquatic world, translates itself into an extremely differentiated range of architectures for the most varied functions.

Those architectures that derive their own formal para-digms and the compositional syntaxes from the world of the machine and the water-related industry belong to the first category of the consonances of mimetic functionalist type.

Considering, only to mention some examples, the Silodam complex, designed by the Dutch firm MVRDV.

This apartment complex, completed in 2002, stands in the middle of one of the channels of the port of Amsterdam. The design is inspired, in an obvious way, to the containerships that populate the ports around the world, and entrusts its identifiability to the reiteration on the facade of modular elements of different colors that correspond to the individual residential and commercial units. The building seems to want to pursue a process of *self-construction*, the random combination of materials available in the same site. The process of esthetic *formativity* appears influenced by the accidental, but profitable responsiveness, to a condition of involuntary: the obsessive presence and availability of the containers, whose iteration suggests common modularities also to the residences, instigate the authors to use them as elementary and available morphemes for other uses and combinations.

The same process is valid for the famous Burj al Arab in Dubai, where the evocation of a sail spread out to the wind appears suggestive, but ambiguous and pretentious, as one of the main problems faced by its designers is precisely of opposing to the force of the wind. The Nemo project (*National Center for Science and Technology*) in Amsterdam enjoys mayor reputation. Here the reference to the form of a ship is explicitly sought in the pattern of a ship prow that juts out over the water. Further the use of the metallic coating in color green water helps to evoke the naval image and establishes



Figure 3: Silodam, MVRDV Architects (www.mvrdv.nl)

a relationship of continuity with the color of the sea. The project *structures* a square placed on its cover, to which you can access by a ramp that follows the wedge-shape profile of the whole building and defines a public terrace overlooking the port of Amsterdam. The organic world of the sea is, as mentioned, the second family of categories of mimetic references to which these architectures seem to be inspired, whose results in many cases, also having the ambition to manifest themselves as very modern architectures, look like some illustrations of science fiction of the first half of the 19th century. In this second category especially those utopian projects that, seeking answers to the potential environmental crises of the next future, foreshadow floating buildings or whole floating cities.

And 'this is the case for example of the floating oceanographic observatory designed by the French architect Rougerie Jaque (www.rougerie.com), whose formal references, that clearly look to the world of crustaceans, seem to come out from a novel by Jules Verne.

The same mimetic and emulative matrix is pursued by Peddle Thorpe Architects in the project for a floating pavilion for Expo 2012 in Yeosu, Korea. The pavilion thought to host a traveling exhibition on the theme of the expo "The living Ocean and Coast", is inspired by the world of the submarine biology, emphasizing the aspects related to the fluidity and the dynamism.

In this kind we can include also the utopian floating cities of Vincent Callebaut: expandable organisms based on the drawing of spores of marine vegetation, are seen as refuges of the future for the population settled in those coastal territories that the sea level rise will make uninhabitable. Lilypad, this is the name of the amphibious city designed by Callebaut, is designed to be able to accommodate 50,000 inhabitants and has been thought as an autonomous organism from the energetic and faunal-vegetal point of view.

To conclude this brief review of "aqua-form" projects it seems appropriate to mention the project of the island in the Mur River in Graz, Austria. Vito Acconci's work stems from the need to create an object able of making the river enjoyed and connected to the urban context.



Figure 4: Fluid, Amphibian Pavilion for the expo 2012, . Peddle Thorp Architects: (www.pta.com)



Figure 5: The floating ecopolis of Lilypad. Vincent Callebaut:www.vincent.callebaut.org

Acconci creates a platform of connection, a shell with organic and enveloping forms played on the dialectic concave-convex. This shell contains several functions: a small bar, an outdoor theater and a playground for children.

3 THE POSSIBLE ARISE OF AN AQUATIC MANNERISM

The analyzed cases highlight how the project themes are equivalent with coherency everywhere in the world. To this reiteration of the project themes it seems to go increasingly corresponding an equally clear diffusion of analogous syntactic linguistic morphemes. The total coherence, with which analogous responses are defined for analogous problems, finds in the field of the colonization of the *liquid territory* a design procedure that seems to be inspired by a, non coded, common “*style*”, almost an *international style* that seems to inspire these architectures to a *suprapersonal and common manner to form themselves* that often corresponds to a substantial impoverishment of the conceptual and formal offer. Often these appear to pursue the research on a relationship between form and context from the reversed signs in which the form follows the context, the function suits to it. The result is often attributed to a casual *formalism*.

These architectures seem to be inspired by an explicit metaphorical willingness encouraged continually in the research on emulative relationships, and entrust all their *communication qualities* (Dorfles 1970) to the reiteration of linguistic elements to which it is entrusted the task to mean simultaneously their belonging to the aquatic context and their being taken out, in dependence of the new functions introduced. In the reiteration of museums in the shape of ship, of terminals in the shape of waves, of residential buildings in the shape of container, it is implied a tendency to the exaltation of the symbolic aspects. The terms of this overtaking, when too insistent, risk the *Kitch*, as “*operations that constitute the esthetic meal of the vast majority.*”

Just as the *International style* was the response in the *stylistic* side to a set of pressures induced by the advent of new technologies and the pursuit of new proposals, so the reiterated functional and linguistic remakes of these architectures seem to face an equal storm. What now anticipated finds a strong motivation for the formation of a linguistic *koine*, also due to the design materials that offer themselves available in the aquatic landscape.

Despite the variety of the accents that every author makes explicit and his specific determination to force the uniformity of this context searching for specificities dictated by the individual context, it is however possible to identify elementary abacus of morphological references, common at the point that they can be encoded, even if at the cost of a partial arbitrariness.

The comparison of the reports of figurative consonance of these architecture with the context and the limited list of the possibilities to deal with the water surface, characterizes a process of constant standardization. A standardization process that certainly doesn't have the force of aspiring, according with the classification proposed by Jacob Burkardt, to the definition of *organic* architecture style. Burkardt meant with the term *organic* that style, present only in the Greek period and in the Gothic one, with its autonomous original symbolic production. Burkardt identified, for counterpoint, in the derived style all the architectural experiences “*forced*” in comparison with the history, never *independently creative* (Burkardt, 1991).

CONCLUSION

This contribution is not to provide definitive conclusions. Rather intends to submit to the debate an issue that is emerging in architecture: the colonization of water for purposes related to infrastructure or to the residence and the worrying and unique aesthetic trend that characterizes these projects. It is believed that this process underway, requires the establishment of a wealth of critical awareness that do not degrade this emerging theme of architecture in an aesthetic fashion. The question that arises is: the growing need of space in our congested cities in the coming years may require a greater use of architectures on the water?. If this trend will be confirmed, the conceptual paradigms of the architect must be prepared to confront a new “tectonic” considering the water, not as a scenic backdrop but as a new *habitat*.

The architectures for the *liquid territory*, although in many cases seem inspired by the same emulative and mimetic tension toward the context, don't appear equipped with an appropriate creative independence. At most one could speak of a decline of fashion in-tended in the meaning of Simmel as the "*charm of the beginning and end together, the charm of novelty and at the same time of the caducity.*"

The complexity of the arguments that allow to find in a repetition of similar attitudes the affirmation of a style, in Architecture as in other artistic or artisan expressions, is such that doesn't allow the access to this term solely on the basis of representative cases of a trend. The history of the styles, their presentation on the stage of the formal evolution, is deeply influenced by the times, the manner and the protagonists of this statement, by the critical paths, by the treaties and the recognitions that mark its birth perhaps only after their extinction.

The *style* corresponds to a specific, original, unusual and historicized worldview that finds in the specificity of an artistic technique its appropriate representation. This *Style*, really a new *environmentalism*, consists in the diffusion of recognizable features, not requiring a theoretical foundation of which anyone can see the tracks.

Thereby recognizing, if not properly and still, the dignity of style to the universe created by contemporary interventions in the areas near the water, at least the affirmation of a *manner*: a widespread and comprehensible approach, but with different accents that however don't make themselves incompatible each other, which build up, therefore, a fruitful relationship with users, generically disposed to recognize that congeniality.

"It is enough a look to the common experience to accept that often it happens to us of imitating what we had almost produced or to have produced what we had certainly imitated: the congeniality offers similar situations, similar exigencies, close problems, common stimulations." (Pareyson, 1988.23)

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ENDNOTES

¹ Thinking to the projects for the Kansai airport, or to Stefano Boeri's proposal of a floating stadium for the city of Genoa, or also to Asadov's project for the recent concourse for floating boulevards along the river side in Moscow.

² See related to this point the work carried on in Holland by Deltasync (www.deltasync.nl) that studies the possibility to protect the Dutch cities from continuous floods that tormented them for centuries, proposing constructive typologies without foundations and able to float on the water.

Syncretistic Vernacular Architecture

Santa Fe, New Mexico

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ABSTRACT:

The subject of this paper is the Westside/Guadalupe Historic District, established in 1983. The Westside originates from seventeenth century pre-industrial building methods and land use patterns associated with agricultural based societies that in many instances were extended family settlements. A predominant characteristic is growth by accretion and modification that often produces an eccentric ad hoc result that can be described as *vernacular* or *folkloric*. This has been popularly called *Santa Fe Vernacular Style*. This paper demonstrates a localized community process of building and place making resulting from the syncretism of various regional and national influences spanning three distinctive eras of development: Spanish Colonial/Mexican Independence (1600-1846), U. S. Territorial (1846-1912), and Statehood (1912-present). Representative examples of Westside buildings are evaluated showing predominant patterns of settlement, spatial configurations, material usage, and architectural detailing delineating a contemporary building tradition based on an accurate understanding of history and local identity.

This paper claims that the Westside community is a relevant example of an authentic self-generating community building process that can continue to thrive through a collaboration of stakeholders; community, client, designer, and contractor. This collaboration will require each stakeholder to have a highly developed understanding of local history *and* the conditions facing modern civilization. This knowledge can inform new construction and the renovation of existing structures with the aim of creating unique and particular environments that value innovation over imitation.

In the human endeavor to claim and sustain culturally relevant forms and spaces for living, architecture plays a dual role in defining and dissolving the physical and psychological borders between cultural groups occupying common domains. Santa Fe, New Mexico is a study of the transition from ancient market place to global market economy balancing the need to sustain authentic community life with the necessity to maintain a tourism industry marketable to consumers who are visitors or newcomers. Northern New Mexico is home to some of the oldest preindustrial folkloric *vernacular*¹ architecture in the United States. A significant portion of the “historic” downtown structures frequented by tourists and “upscale” shoppers were built and rebuilt, from the early 1900’s onward, in a *modern vernacular*² remaking of an imagined world rooted in historical fact and fantasy.

This has created a local attitude about architecture framing an original approach to a culture tourism industry; a form of commerce capable of generating substantial economic benefits in many ways and at various levels. Santa Fe is distinctive, and thus *vernacular*³ in the fact that language, food, art, dress, and building traditions are uniquely Santa Fe and particular to the immediate regions surrounding the city. Paul Oliver defines vernacular architecture as “*The dwellings and places of the people*”, *these dwellings relate to specific environmental contexts and available resources, and they are customarily owner- or community-built utilizing traditional technologies.*” He asserts that all forms of vernacular architecture are designed to address specific needs, and express the values, economies, and “*ways of living of the cultures that produce them*.”⁴

The Westside/Guadalupe Historic District was established in 1983 and is the most recent of five historic districts in Santa Fe. It is the combination of two neighborhoods that have slowly grown together defining a distinct architectural terrain within Santa Fe. The term “Westside” refers to the western extension of San Francisco Street north of the Santa Fe River, and a small rural settlement to the south named the Barrio de Guadalupe. The majority of structures are consistent with the New Mexican owner-as-builder tradition that originates from pre-industrial building methods and land

use patterns associated with village making and agricultural based settlements that in many instances are extended family settlements.

A particular attribute of primitive mud or adobe construction is its instability as a long term building material. Real sun dried adobe brick with mud plaster has a tendency to melt and erode. Early foundation systems were prone to shift, and heavy timber ceiling beams covered with a thick layer of dried mud tended to force walls to thrust outward. Exterior load bearing adobe walls were constantly being strengthened and rebuilt. The canted or battered look of these walls is often due to periodic stabilization. A simple method to counteract lateral forces from the roof was to shore up the exterior walls with additional buttressing. Real adobe can last for centuries with constant care. Because of this periodic maintenance and reconstruction adobe buildings in New Mexico have a plastic quality in that they change and grow over time allowing builders the opportunity to introduce elements from different architectural styles and eras. The syncretistic process is often ongoing and not limited to a onetime occurrence.

One of the best-known examples of this is the Palace of the Governors located on the Santa Fe Plaza. Built by the Spanish in the early 1600's it has seen numerous reconstructions over the centuries. No one knows exactly what it looked like during the Spanish Colonial period, but early photographs indicate that by 1868 a wood colonnade in the Greek revival style had been added and by 1881 the main façade had been rebuilt in the Queen Anne style popular in the territorial era. In 1909 the palace became the property of the Museum of New Mexico, and by 1913 the original structure was rebuilt again to resemble the Spanish Colonial style based on a mix of fact and conjecture. In each of the earlier renovations the intent was to remake the Palace into a contemporary building in tune with the prevailing currents of architectural style. The 1913 renovation signifies the beginning of the modern Santa Fe Revival movement that rejected contemporary mainstream influences and looked to the past for inspiration. Like the Santa Fe Plaza, the development of the Westside and Guadalupe neighborhoods parallel the three stages of cultural development in Northern New Mexico.

SPANISH COLONIAL/MEXICAN INDEPENDENCE: 1610-1846

Spanish colonists from Mexico City founded Santa Fe in 1610. The Spanish combined regional Pueblo mud building traditions with Spanish-Moorish adobe brick construction techniques creating the distinctive elements of Santa Fe style architecture that exist to the present day such as the *portal* or covered walk way, hewn wood beams called *vigas*, and timber supported lintels for narrow doors and windows.

Early Santa Fe was a blend of colonial Mexican cities and Pre-Columbian villages creating the factual basis for the modern day Spanish/Pueblo or Spanish/Indian style of architecture that is preeminent in Santa Fe today. The Spanish Colonial period officially ended in 1822 when Mexico won independence from Spain, but architecture remained virtually unchanged throughout the Mexican Independence period. The typical building of this era was a linear progression of single rooms that formed either straight line, L shaped, or U shaped configurations.⁵ (See Figure 1)

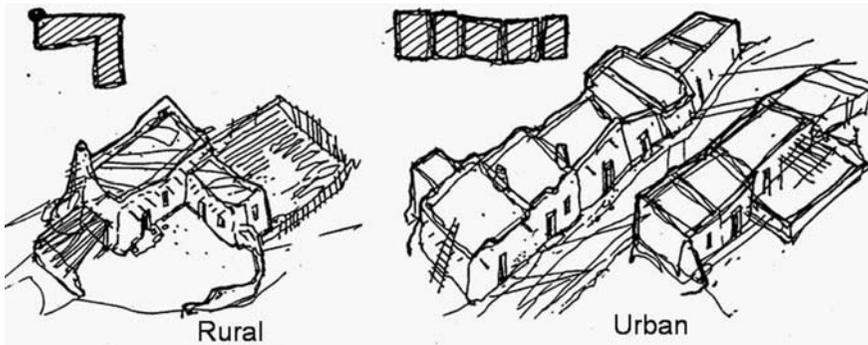


Figure 1. Mexican Colonial Period building configurations

AMERICAN TERRITORIAL: 1846-1912

In 1846 the United States went to war with Mexico and Brigadier General Stephen Kearny occupied Santa Fe. In 1848 U.S. troops captured Mexico City and Nuevo Mexico became the territorial property of the U.S. under the Treaty of Guadalupe Hidalgo. Like the Spanish before them the Americans, out of necessity, “forced a merging of Pueblo Spanish style elements with the Greek Revival taste of these Anglo newcomers”⁶

In the late 1800’s Victorian architectural influences were also blended with Pueblo building elements. (See figures 2 and 3) The Americans integrated adobe for walls with milled woodwork for columns and openings, fired brick coping, and pitched roofs creating the Territorial or Anglo/Pueblo style. A widely held view during the Territorial Period regarded mud architecture as a hindrance to statehood not being “American” in origin and further promoting the “backwardness” of New Mexico. Non-English speaking Catholics were not regarded as prospective loyal citizens and adobe buildings accentuated their presence. In the more developed areas of Santa Fe, the trend became contemporary American architecture ranging from Romanesque to Italianate styles attempting to look typically American while downplaying a Spanish/Mexican past. “Between cultures of such opposite temperament, conflict was inevitable”⁷ Only in the poorer sections of town were the traditional communal adobe building techniques continued as a matter of survival and dire necessity. In the contest for ideological terrain, architecture played a preminent role in the early history of Santa Fe. As the 20th century began it looked as though adobe architecture would fade into history as Santa Fe, Albuquerque, and Las Vegas, New Mexico increasingly adopted the look of any typical American city.

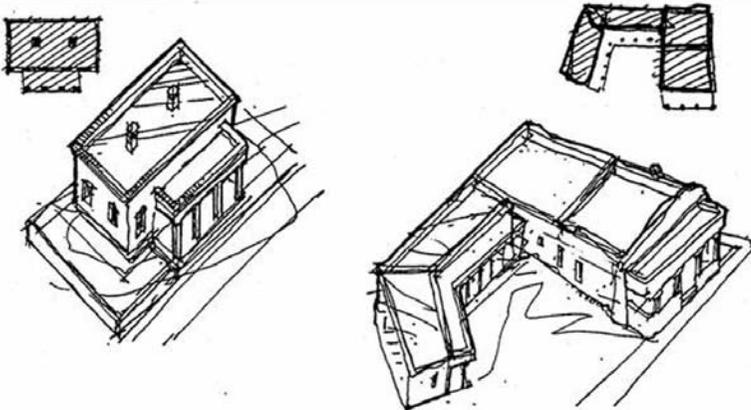


Figure 2. Territorial 1850-1870 Spanish Pueblo-Greek Revival

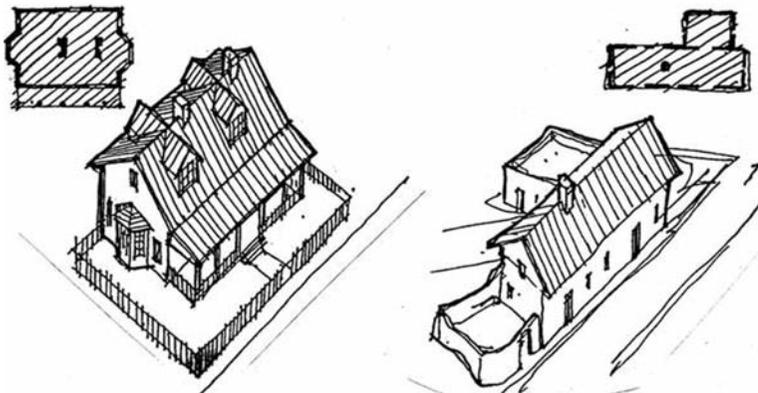


Figure 3. Territorial 1870-1900 Spanish Pueblo-Victorian

NEW MEXICO STATEHOOD: 1912-PRESENT

Following statehood, a dramatic shift in attitudes began to take place in Santa Fe. The new tourism industry, created by the development of trans-continental railroad transportation, capitalized on the growing interest in Southwest Indian cultures now accessible to travelers passing through Santa Fe. Archaeologists pioneered preservation techniques in discovering the ancient places of cultures long vanished at Chaco and Bandalier. Surviving tribal centers at Acoma and Taos intrigued scholar and tourist alike spurring an interest in preserving Native American history through regional tourism. New Pueblo and Territorial style building were constructed throughout downtown Santa Fe that were conceptually based on authentic adobe buildings from antiquity, but were actually built of brick and clay tile plastered with cement-based stuccos resembling adobe construction. At the same time, a controversial approach to archaeology was born: ruins were excavated and stabilized and then new construction was added enabling the casual tourists to experience the building as it had been, or in some cases as it might have been. Motivated by a concern that Santa Fe was becoming too much like any typical American city, and the potential economic benefits of being different, many existing buildings throughout New Mexico underwent façade reconstruction to become more “historically authentic” even though the effort was not aimed at accurate preservation but mythical representation. This process of “adobification,” is a particular Santa Fe phenomenon. More than an architectural “facelift”, this practice can be understood as a form of cultural denial by deliberately removing the real history of social contest and political conflict and replacing it with a mythical sense of place.

The emphasis instead on a romantic story deprives people of an image of themselves as active agents for contemporary social change. Such fictionalized reality also inhibits the hybridization of the traditional with the modern, the local with the international, which is necessary for the continued vitality and relevance of any local culture.⁸

It can be argued that the territorial era addition of Victorian elements to the Palace of the Governors was stylistically incorrect and yet these earlier renovations demonstrate the ability of a regional architectural method to remain viable by bridging regional history with current trends and attitudes.

The Spanish/Pueblo revival movement, ushered in by early 20th century idealists (a loose confederation of architects, artists, archeologists, and civic boosters) effectively ended the original Santa Fe process of inventive adaptation, replacing it with a fixed and rigidly defined style that resisted innovation and experimentation. “The philosophy of the Arts and Crafts Movement provided a framework for combining a clarified nationalism, a concern for social reforms, economic revival and vernacular art.”⁹ The 1957 Santa Fe Historical District Ordinance, one of the first in the U.S., mandated that all new construction and renovation in historic districts conform to stylistic guidelines that recognized two categories of architectural style. *Old Santa Fe Style*, or building designs that strictly adhere to Spanish/Pueblo Revival or Territorial Revival architectural rules, and *Recent Santa Fe Style* defined by a set of criteria that includes colors, details, and massing that achieve compatibility with historic revival buildings. The modern visual continuity of Santa Fe relies heavily on the effort to maintain unity through stylistic homogeneity or compatibility. This is informed by the traditional folk vernacular of the preindustrial age resulting from ethnicity, geography, site and landscape, and building materials and techniques unique to the area and to the time period.¹⁰

THE WESTSIDE/GUADALUPE HISTORIC DISTRICT TODAY

Since the 1950’s, the Westside Neighborhood has gradually become part of modern-historic Santa Fe, physically and psychologically, although long time residents still refer to this community as “the village” because of its unified small town scale and the interconnected character of its buildings. Today, the natural borders of the Westside are giving way to the prevalent trend of historic iconography most often associated with popular Pueblo Revival style that for a century has proliferated throughout mainstream Santa Fe particularly around the Plaza and in the more affluent neighborhoods. Until the 1980’s, the Westside neighborhood was traditionally considered separate from the ideal rebuilding of Santa Fe before the age of tourism and gentrification.

During the 1920s the neighborhood population doubled, and then more than doubled again by the end of World War II. Of the 686 buildings surveyed in the Westside/Guadalupe Historic District in 1985, 71% were built before 1946. The relatively flat level strips of irrigated land were easily divided into building lots, with narrow lanes the along property lines giving access to the houses. This growth occurred not as major subdivisions but as piecemeal divisions of individual agricultural parcels into small building lots.¹¹

The Westside neighborhood thrived being physically close to Santa Fe and borrowing freely from the various contemporary architectural influences of the day. It survived being psychologically distant from the popular image of modern Santa Fe being a working class neighborhood separated from downtown and the plaza by the rail yard. Because of this separateness much of the Westside neighborhood escaped the 20th century revival movement that first swept downtown Santa Fe after 1912. The term *Santa Fe Vernacular Style* is often used in Santa Fe today to identify structures that are non-professionally built, constructed primarily of regional materials, and to denote buildings that express a fusion, or syncretism of Hispanic and Anglo cultural ideologies through a localized convention of building borrowing freely from a wide range of influences particular to, or in some cases common to each group. Figure 4 shows the number and location of buildings in the Santa Fe Vernacular Style. Santa Fe or Hispanic Vernacular architecture differs from professional built “Pueblo Revival Style” architecture in the inventive process of building and the personalized aesthetic intent expressed by the owner/designer/builder.

A predominant characteristic is growth by accretion or periodic expansion and adaptation. (See figure 5) It is a regional method of building that is particular to the Westside. Van Dorn Hooker, past University Architect at the University of New Mexico, offers a definition of vernacular architecture that addresses the relationship between culture and means of production.

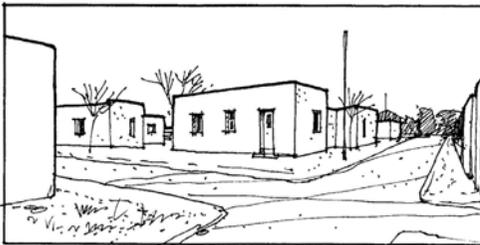


Figure 4 Map of the Westside/Guadalupe Historic District showing number and location of Vernacular buildings (darkened).

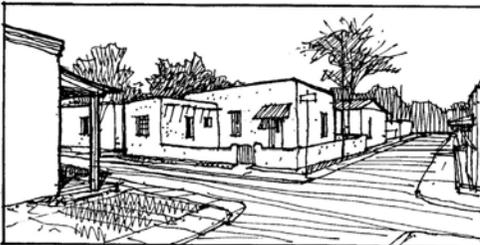
The term 'vernacular' is borrowed from language, where it means 'the language or dialect... naturally spoken by the people of a particular country or district.' The phrase 'vernacular architecture' was first used in England in the 1850's to describe medieval houses which had no other place in the artistic and stylistic categories set down by 19th century academics. More recently it has come to mean any structure devoted to everyday uses built by unschooled, but not unskilled, craftsmen working within a commonly understood cultural and technical tradition.¹²

The distinctive architectural character of the Westside/Guadalupe Historic District results from a syncretism¹³ of regional Hispanic building methods and 19th and 20th century Anglo/American architectural trends. It is a cross-section of the various layers of social and cultural influences that have shaped Santa Fe and the American Southwest. The evolution of house types from 1850 to 1950 (see figure 6) shows that as emergent Anglo-American architectural trends filtered into the Westside, the mostly adobe constructed structures adopted various patterns regarding roof, porch, and doors and windows.

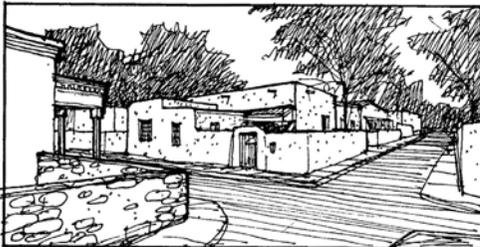
Prior to the arrival of the Americans, Hispanic traditions in building favored the enclosed courtyard scheme (See figure 7.) that usually started as an "L" shaped configuration that in time would grow to enclose a private and protected interior space. This type of building was more common in the outlying areas of town associated with agriculture. In the more dense areas of the interior city, artisans and merchants preferred the linear organization of single file rooms along the street edge (See figure 8) Doors opened directly onto the street and formed a hard edge. As Anglo and Hispanic cultures began to merge in the 19th century, density increased forming ad-hoc cluster settlements that were often positioned near water and organized around the acequias or irrigation ditches that ran from the Santa Fe River into the fields. (See figure 9.)



ESTABLISH



EXPAND



COMPLETE

Figure 5 Three stages of incremental growth

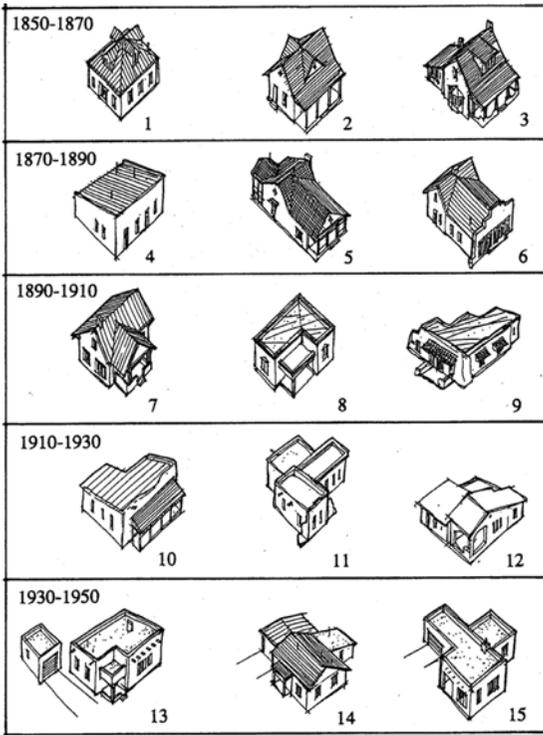


Figure 6 Syncretistic Evolutions of House Types. Westside/Guadalupe Historic District 1850-1950

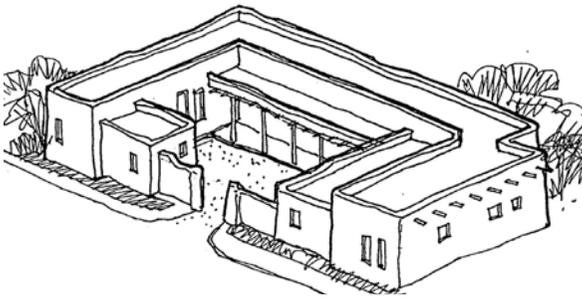


Figure 7 Enclosed courtyard house.

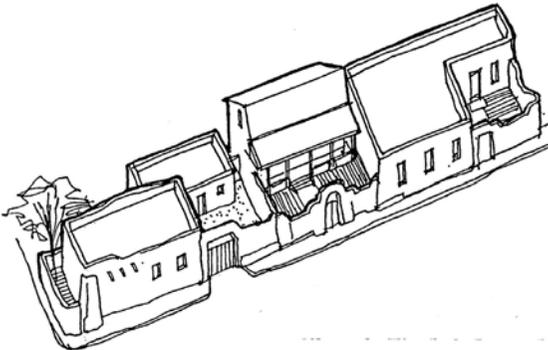


Figure 8 Linear street edge formed by attached houses and walls.



Figure 9 Multiple house units in informal clusters.

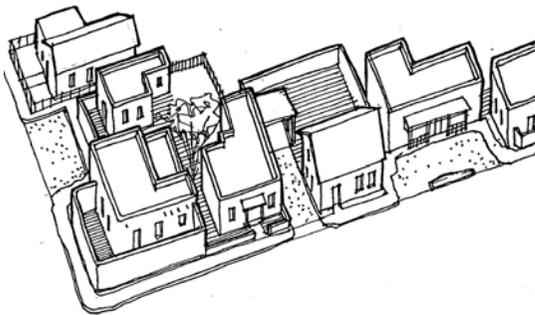


Figure 10 Mixed housing types with various yard configurations.

In time the Anglo American preference for a front yard necessitated the placement of the building back from the curb creating an undulating effect along the street edge. (See figure 10) Some residents preferred low picket fences and open front yards where vehicles could be parked while others constructed high privacy walls.

This random relationship of house to street edge combined with a highly unstructured approach to creating private drives and alleys has over time defined the vernacular and organic character of this neighborhood.

The Larragoite Residence at 803 Agua Fria Street (See figure 11.) was first documented on a warranty deed dated 1866 in the name of Armando Larragoite. This building has served as a residence, a grocery store, a liquor store, and a meat market before being restored to a private residence for Larragoite's descendants, who still live there today. The gables are covered with wood shingles and the roof is sheathed in tern plate metal, a roofing material introduced to Santa Fe in the 19th century. Considered an excellent example of Santa Fe Vernacular style the structure shows incremental additions and modifications that reflect various architectural influences. The original wall construction is load-bearing adobe that once supported flat mud roofs. Many Hispanic and Anglo homeowners constructed pitched roofs over the original structures as a modern improvement over the leaky mud roof.

This also created additional space for storage, and in some cases for living. One chimney is brick and the other is stone indicating different times of construction. The porches rest on stone and wood columns reminiscent of the Arts and Crafts style.

The residence at 707 Agua Fria originated as an adobe flat roofed farmhouse dating back to the 1800s (see figure 11). The original adobe box has been flanked by newer additions including shallow



Figure 11 Larragoite R residence at 803 Agua Fria Street



Figure 12 Residence at 707 Agua Fria Street



Figure 13 Residence at 130 Romero Street



Figure 14 455 W. San Francisco Street



Figure 15 511 W. San Francisco Street

pitched roofs covered with pressed tin to look like Spanish tile reminiscent of the California Mission Style. The rock pedestals and triangular attic windows are evidence of the Arts and Crafts bungalow influence.

The residence at 130 Romero Street is a square “salt box” plan with a projecting hipped ridge dormer again reminiscent of the Craftsman influence (see figure 13). The front porch is carried on Greek revival style columns supported by adobe pedestals connected by Victorian style lathed balustrades. The tall windows under the porch recall the Queen Anne period.

The small business located at 455 W. San Francisco Street demonstrates the blending of Pueblo and Art Deco massing popular in the 1920’s and 1930s (see figure 14). California Mission Style canopies of metal “tile” roofing on cast iron frames supported by brackets cover wide large windows made possible by the introduction of clay tile wall construction. Buttressing at the corner is decorative and not structural indicating an attempt to incorporate Pueblo Revival aesthetic.

Dating from the late 1800s the two-story structure at 511 W. San Francisco Street (see Figure 15) is illustrative of the syncretism of Hispanic adobe architecture and Anglo territorial influences. The doors feature transoms and sidelights typical of the Queen Ann style. The high-pitched roof is standing seam metal accommodating cross-gabled ridge dormer windows. This mixing of Hispanic and Victorian elements is typical of the period from 1880 to 1920 when builders throughout remote villages and rural communities of northern New Mexico merged local traditions with national architectural themes and configurations.

The concept of a local or national culture is a paradoxical proposition not only because of the present obvious antithesis between rooted culture and universal civilization but also because all cultures, both ancient and modern, seem to have depended for their intrinsic development on a certain cross-fertilization with other cultures.¹⁴

One of the most recognizable elements of Westside vernacular architecture is the walled entrance. Owing its origins to the Spanish *zaguan* entrance of the traditional enclosed hacienda plan, this element is often the most elaborate expression of the occupant and in some instances is the handiwork of the building owner, or a local artisan. Westside residents employ a wide range of technical and artistic approaches to the entrance in the design of the door and the framing of the entrance with arch or lintel. (See figure 16)

THE WESTSIDE/GUADALUPE HISTORIC DISTRICT TOMORROW

In some cases, the descendants of the original owners and/or builders still reside in the Westside/Guadalupe Historic District. Others have moved on, choosing to take advantage of escalating real estate prices by selling to new owners from outside the local ethnic and cultural community. The Westside is no longer an “affordable” Santa Fe neighborhood as it once was. Modern real estate practices emphasize the principles of industrial standardization and rely less on the uniqueness of vernacular craft. Speculators and developers buy out Westside residents and “rebuild” the old structures to resemble fashionable Modernistic Santa Fe Style architecture. (See figure 17).

Modernism did its immense damage in these ways: by divorcing the practice of building from history and the traditional meanings of building; by promoting a species of urbanism that destroyed the age-old social arrangements and, with, the urban life as a general proposition; and by creating a physical setting for man that failed to respect the limits of scale, growth, and the consumption of natural resources¹⁵.

James Kunstler’s observation on the negative impacts modernism had on the making of livable and meaningful communities suggests the need to study the contemporary possibilities that spring from syncretistic vernacularism. The original intent of the Santa Fe Pueblo Revival was to resist the effects of mainstream American culture while all along relying on that very same culture to find Santa Fe distinctive and different. The Westside helps to define Santa Fe not so much as a city different from other places, but a city differentiated against itself tempted to erase the evidence of a turbulent, multi-cultural, self-expressive, and less romantic reality. A completely harmonious architectural landscape is not necessarily evidence of an authentic community process. The Westside resulted from nearly two centuries of conflict arising from the clash of Hispanic and Anglo-American cultures and the



Figure 16 Various entrance schemes typical of owner- builder inventiveness.

inevitable blending of those cultures that over time fused various architectural preferences to create an extensive vocabulary of settlement patterns, building forms, and detailing.

Throughout the American Southwest modern architects blend innovation with interpretations of traditional themes. Antoine Predock's Nelson Center at Arizona State University in Tempe, Frank Ghery's Edgemar complex in Santa Monica, California, and Ricardo Legoretta's Visual Arts Center at The College of Santa Fe (see figure 18) fuse contemporary architectural themes with climatic, cultural, and material elements of Southwestern building.

Legoretta's Visual Arts Center is a relevant application of syncretistic vernacularism showing how *"local and regional identities are constructed within - rather than against - the context of the modern."*¹⁶ The process of syncretism, the fusion of two or more different inflectional forms so as to form a whole, is the legacy of the Westside/Guadalupe Historic District. This process of syncretistic vernacular is widespread throughout world history particularly in countries with a history of colonialism and



Figure 17 Contemporary Apartment Complex designed in the Recent Santa Fe Style.



Figure 18 Visual Arts Center College of Santa Fe Ricardo Legoretta Architect

foreign invasion including Mexico, Indonesia, India, and the French Speaking Creole of Louisiana, to name just a few. The blending of architectural preferences is but one of the many ways syncretism or contextualization occurs between different cultural groups. Syncretism is often observed in cultural myths, language, and religion. *“The concept of syncretism has been coined to describe the mixing of elements from different religious sources, sometimes as a descriptive term, sometimes as a pejorative concept.”*¹⁷ The syncretistic response to the merging of Anglo and Hispanic cultures in New Mexico during the 19th and early 20th centuries was not a simple two-way trade. It was a conscious and deliberate action at one level and an unconscious and natural occurrence at other levels. To merely imitate history using a prescriptive approach to modern regional building based on a purely academic categorization of Spanish-Anglo vernacular expressions would repeat the excesses of the Spanish Pueblo Revival. Excesses that ultimately generated an etiological mythic in promoting what Wilson calls a *“fictionalized reality”*, or a false history of place.

In the forward to *The Place of Houses*, Charles Moore claimed that *“traditions have great power precisely because they present us with possibilities and guides that can support invention.”*¹⁸ It is a community based process that challenges the ordinary efficacy of the modern consumerist driven housing product. The continued learning of, or the natural understanding of local traditions, expressed in the process and intent of the vernacular owner/builder, is evidence of a *“connected”* and *“rooted”* community capable of sustaining and perpetuating a distinctive architectural character. A neighborhood identity made authentic through the practice of locally understood cultural and technical building traditions emphasizing a dissonant and eclectic reality, the hybridization of the traditional with the modern, over a homogenous sense of oneness.

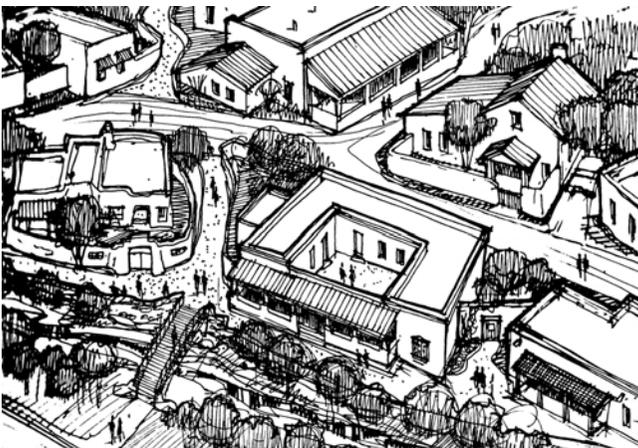


Figure 19 Aerial perspective showing detached large scale housing in courtyard and walled yard configurations.

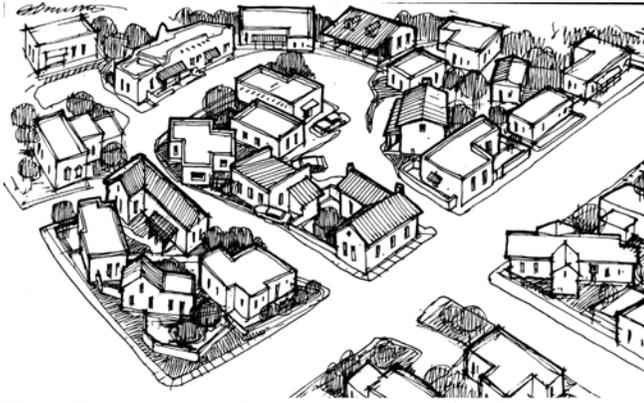


Figure 20 Aerial perspective showing organic clusters of attached and stand alone medium and small scale housing.

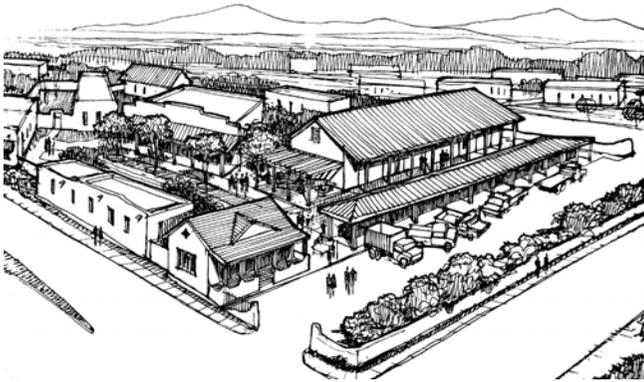


Figure 21 aerial perspectives showing conceptual mixed use development of small scale retail and multi-family housing units.

Learning from the Westside/Guadalupe Neighborhood can inspire the development of many local architectural terrains that offer more than the average suburban tract housing development. Figures 19-21 show three possible versions of new building design and community planning schemes that use traditional *and* modern vernacular forms and configurations to create contemporary development that denotes a specific sensitivity to place.

A distinctive Mexican-American vernacular has continued to evolve largely unrecognized by tourists, historic-preservationist, and architectural revivalists. This owner-built vernacular continues the Spanish-Mexican tradition unbroken, with a healthy admixture of Anglo-American influences.¹⁹

In *The Vernacular, Memory, and Architecture* Stanford Anderson makes a distinction between *social memories* or traditions in building that are embodied within preliterate societies, and *disciplinary memory* as practiced by professional architects in literate societies. His central thesis is that a modern vernacular architecture can be understood as the cohesion of social and disciplinary memory, and that there exists the possibility for a natural relationship between a society and its artifacts.²⁰ Anderson's claim has particular importance for historic cultural neighborhoods like the Westside because the owner-as-builder tradition is disappearing. The continued vitality and sustainability of this place is largely up to the contractors, developers, and architects and designers that will oversee new and renovation construction, and to the next generation of home owners that will either initiate the creation of new structures, or continue the preservation of existing structures. There is no single vision for the future of the Westside that would satisfy the requirement for a simple prescriptive

solution. "Greater homogeneity and greater heterogeneity are...simultaneously at work in the often chaotic negotiations between groups and cultures"²¹ This is true in the case of 20th century Santa Fe as evidenced by the eccentric folk character of the Westside contrasted against the "vernacularized" modern structures that aside from basic regional stylistic references are by all standards conventional American buildings.

A modern syncretistic Santa Fe vernacular architecture can be defined as an ongoing and evolving way of building those bridges the past with the inevitable future. It can be relevant today and in the future if it can foster the cohesion of traditional social, cultural, and ethnic preferences with modern consumerist agendas. Continue to fuse local craft with global technologies and materials. And, merge modern regulated zoning ordinances and building codes with historic traditions of ad hoc vernacular inventiveness. An inventiveness that is embodied in a commonly understood tradition that values innovation over imitation. All three of these goals require a process of building in which the community, client, designer, and contractor will require a highly developed understanding of local traditions, regional and national history, and the multifaceted and ever-changing realities of an emerging global society.

All photographs and illustrations are by the author

ENDNOTES

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3. The origin of the word vernacular is Latin vernaculus meaning slave, domestic, native, indigenous. The term has come to mean (1) the locally spoken dialect of a group of people of common interest or origin. (2) The building style of a particular group, locality, or climatic region.
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Information Urbanism

Parametric urbanism in junction with GIS data processing & fabrication

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ABSTRACT:

Parametric Urbanism, pioneered by Zaha Hadid & Patrik Schumacher Architects with support coming from advanced computational technology, has been the interest of architects and urban designers in recent years. This new design thinking has been used in projects ranging from large scale urban development to building façade/surface design. However, the integration of demographics, cultural, and human factors into this computer controlled equation has so far been neglected. The gap between a simplified condition in the parametric design process and the actual complex urban context in the real world raises the questions of the parametric urbanism manifesto. .

The authors present a study investigating the information processing of Parametric Urbanism and describe a new procedure coined -*Information Urbanism*. Unlike parametric urbanism, *Information Urbanism* considers cultural cues and demographics as input parameters. *Information urbanism* is defined as a hybrid method which seeks logical urban forms and analyzes its' importance through urban design education. The authors extended this method by exploring, collecting, analyzing, and visualizing urban information and physically representing the information through digital fabrication technology.

The research presented within this paper is intended to realize the potential of quantifying demographic, social, and cultural data into a parametric equation. In these experiments, the integration of non-geometrical parameters within the form seeking and fabrication process resulted in a series of conceptual make-ups of city. The models were developed by manipulating zoning, transportation network, city block and various building types. Ultimately, *Information Urbanism* looks to build upon the strengths pre-defined in the Parametric Urbanism method and capture the benefits of Geographic Information System (GIS) by seamlessly integrating vital geo-spatial components in the equation and altering the way people explore the possible design solutions in order to generate the ideal urban forms.

KEYWORDS: Parametric Urbanism, Geographic Information Model, Digital Fabrication

INTRODUCTION

Information Urbanism is a collaborative research project focusing on the integration of Geographic Information System with the theory of parametric urbanism where the emphasis is placed on data collection, pattern analysis, visualization, parametric spatial modeling, and physical representation. This exploration of spatial diagramming, through digital modeling and fabrication, showcases how the urban phenomenon and its geospatial pattern can be interpolated into parametrically controlled forms which can later be translated into design solutions. Patrick Schumacher describes how the parametric thinking “confronts both, the remaining vestiges of Modernism’s monotony, and the cacophony of the urban chaos that has sprung up in the wake of Modernism’s demise, with a complex, variegated order inspired by the self-organizing processes of nature” (Schumacher 2010). This design ideology places emphasis on variation and correlation rather than a linear pipeline that does not allow for the exchange of information. The design solution, either a piece of furniture or an urban form, is explored as a network of parameters. “Thus everything is potentially made to network and resonate with everything else” (Schumacher 2010). The supporting theories emphasize the activity of event parameters within the urban life process. Parametric Urbanism echoes morphogenetic urbanism, swarm urbanism, and rhizomatic urbanism. However, it has a very distinct integration with computation technology supported by advanced 3D programs and computer scripting.

This method has been demonstrated by Zaha Hadid & Patrik Schumacher Architects in several large scale urban design project such as Soho China, Beijing, Stone Towers, New Cairo and Expo City, Cairo. By placing parameters on the social event and including contextual information the key function of the parametric script is used as a form seeking method and ultimately generates the final solution without any reference to contextual or demographic information. Although parametric urbanism has been promoted by the practice of Zaha Hadid & Patrik Schumacher Architects and has been taught in Architecture Association (AA) for several years, the integration of demographics, cultural and human factors into this computer controlled equation (virtually molded with points, lines, planes, and volumes) has not been fully discussed under the umbrella of parametric design. The way to generate urban forms that contain layers of information still remains as a mysterious process. As a result, the audience was left under the impression that ideological manifesto of parametric urbanism distinguished Zaha's architectural style. Therefore, we are left with designers not knowing how to model or simulate the form from the parametric drivers, or more importantly how to interpolate the information which is presented. The gap between a simplified condition in the parametric design process and the actual complex urban system in the real world raises the curiosity and questions the design process of parametric urbanism in practice.

The authors recognize the philosophical significance of parametric urbanism, as well as its lacking of technological explanations of information processing. Our research goal focuses on the process of parameterization of geospatial information into 2D patterns, 3D forms, and experiments various methods to represent the information physically with CAD/CAM tools.

I. INFORMATION PROCESSING FABRICATION

The interaction between human activity and the urban form is essential in understanding a generative city design. As Neil Leach described in Swarm-urbanism, "it as though the city is 'formed' by registering the impulses of human occupation, much as the sheets on our beds, for example, record the movements of our bodies through the night. But so, too, the city constrains the possibilities of human movement and demographics through its very physicality. There is, therefore, in Deleuzian terms, a form of reciprocal presupposition between city and occupants. The city modifies its occupants, no less than the occupants modify the city. Over time the fabric of the city evolves through interaction with its inhabitants." (Leach, 2010).

The first step of our study is the collection and interpolation of demographic information from Geographic Information System (GIS) application. GIS acts as the data collector of "impulse of human occupation" (Leach, 2010). To explore this essential component of information urbanism, the authors investigated the process of using parametric modeling as a new method to convert non-geometric information from GIS databases into a meaningful 3D diagrams. With projects produced in urban design courses, and independent study taught in 2010, the authors and a group of students presented a study investigating the new workflow of using GIS and fabrication within the urban design field and described a procedure for exploring, collecting, analyzing, and 3D representing of urban information from Census data by diagrammatic digital models and fabricated physical models. The research team manipulated the quantifiable GIS data of two case studies, Cincinnati, Ohio and Savannah, Georgia by computing political, social, and economic data into the 3D topographic representation.

In this process, various GIS data themes such as zoning, transportation network, city block and various building types were visualized as a series of virtual models, each of which exclusively responded to its GIS information input. These virtual models record the continuous process of urban form morphing, mutating impacted by the various force/field simultaneously. These models are rendered as a storyboard to simulate the data processing and its interaction within a neutral urban grid. As GIS data imprints the urban form, the authors considered these digital representation models as ambiguous urban diagrams. Here the factor of scale was left absent from discussion and analysis as it allowed the urban fabric to manifest itself based on the human input and reason. The outcome either be diagram or photorealistic renderings, can change people's perception of existing urban landscape and inspire designers to understand the urban form in a new perspective.

The layers of information presented in the digital portion of this research were then explored by the physical fabrication of architectural or urban artifacts. By digitally fabricating the forms and diagrams we were able to experience the urban information through the physical act of making and allowed another opportunity to design the outcome. The integration of non-geometrical parameters such as age, gender, race, poverty level, education level, employment status, family income, and method to travel, were processed and influenced the 3D form. This process was explored as datasets that could be fabricated through a variety of techniques. Ultimately, the results would be read as a physical diagram that revealed information about the series of conceptual make-ups of urban topography. These forms were fabricated by laser cutting and CNC milling various materials. The importance of realizing these conceptual models in the physical world was explored as a way to directly correlate various fabrication techniques such as layering, tessellation and contouring, to the urban landscape properties such as zoning, building massing and grid pattern in a diagrammatic way. Still, through the fabrication process the artifacts maintained the ambiguity and flexibility for designers to translate these physical artifacts into their own interpolations.

2.EXPLORATION OF THE WORKING PROCESS

2.1. STEP ONE. INFORMATION MODELING

This process first started with information from the local census report and GIS data set. Once the geospatial information was compiled, it was then filtered and manually selected based on its significance in term of spatial pattern recognition. In our experiments, data of Cincinnati, Ohio and Savannah, Georgia from the U.S. Census Bureau was used to develop a demographic study on the geospatial information. The information is visualized as thematic maps with gradient color to represent the quantifiable value from the data base. The color value of each pixel in the GIS thematic map is then been used as a parameter (range 0-256) to drive a rule based 3D modeling. A homogeneous grid was set up as the representation of initial global structure and then later deformed by the local actions, like the effect of “local action on global structure” defined by Batty. (Batty. 2007) We use both customized MEL and Grasshopper scripts, as well as advanced modeling tools such as Maya and Rhino to construct the 3D information model from these 2D parameters. Information modeling comprises of infinite possibilities with controllable variables within a parametric framework. These variables are then run through a series of alterations to morph into abstract urban forms.

For instance, we created White, Black, Hispanic, and Asian population thematic map of Cincinnati and studied the pattern overlaid with the railroad system to explore their correlations. By taking this 2D information into Photoshop to manipulate the color value through selected filters, we could

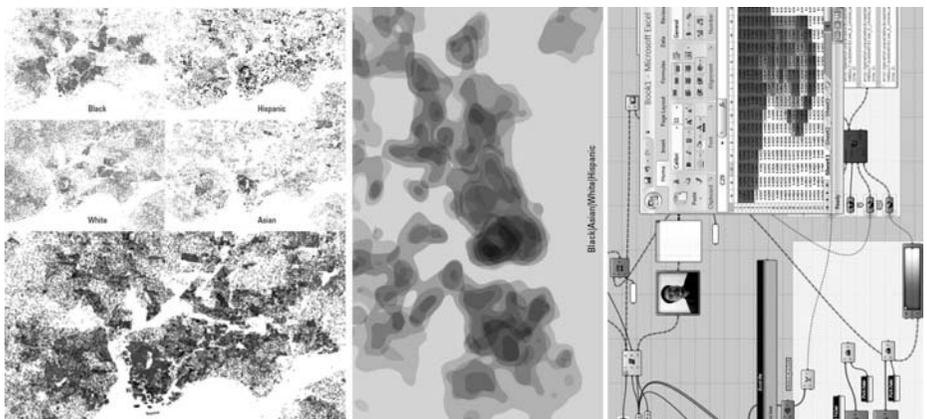


Figure 1: GIS thematic maps allowed us to extract geospatial data and convert it into raster images. By isolating major demographics, students were able to export these raster images into Excel, Grasshopper, Photoshop to fine tune the data in a way that the polygon mesh in 3D program could interact with the images¹

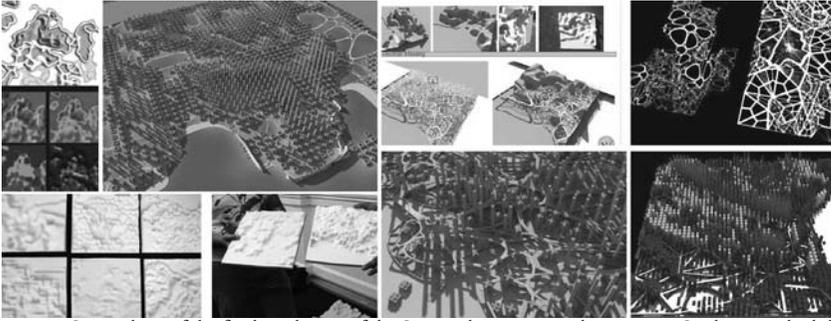


Figure 2: Screenshots of the final resolution of the Savannah project taught in 2010. Students applied the image-based information to the 3D surfaces and then applying the weave pattern script. ¹

mix, eliminate, move and separate our findings. We also extracted the information with image sampling processes in a grasshopper script and then streamed the information to a Excel sheet for further calculations (Figure 1). A new method to convert image-based data into a tessellated 3D polygonal mesh was developed in Maya. These data-driven poly shapes allowed for automatic surface tessellation, and the generation of the mutating areas within a generic grid system (Figure 2).

As a result of the digital representation, the information presented in the 2D maps and 3D models empowered one to draw their own conclusions and develop several intriguing design schemes. The authors view these generated diagrams as a scale-less drawing. It is only when these diagrams are taken by an architect or urban designer that the issue of scale is represented. The layers of information such as streets, pedestrian walkways, and building mass can all be directly extracted from the diagrams. As a result, we have an urban form that is influenced and justified by information that is processed and driven by human and computer interaction.

2.2.STEP TWO: FABRICATION

With the newly generated data the creation of physical models through CNC milling and laser cutting was relatively simple. The filtered data was taken into Rhino and Maya program which allowed us to manipulate and control the spatial pattern and generate the appropriate file for digital fabrication. As a result we translated the abstract information into cutting patterns, tool paths, and controlling information of the energy and speed of laser beam. Here, a numeric GIS dataset is taken as input and generates the scripts for Laser cutting and CNC milling. These artifacts were informed by the none-geometric GIS data processing and not designed arbitrarily by the researchers and fabricators. The authors' only influence on the computer generated diagrams was to manipulate the information into 2D patterns or 3D tool path that would highlight various instances. While doing this process, the authors had to take into account material selection, tagging system, fabrication technique, and machine processes. (Figure 3).

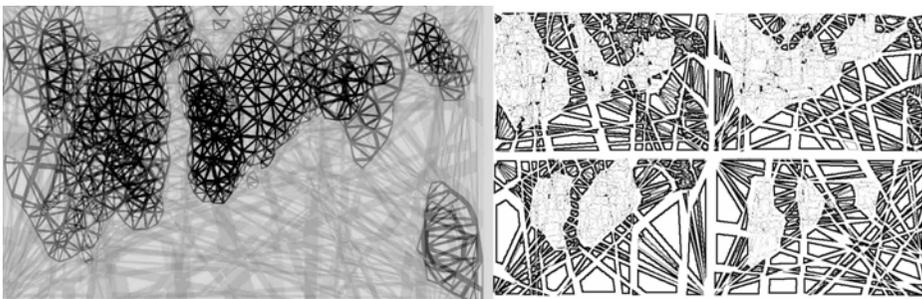


Figure 3. In a course taught in 2010. Students used various maps to study the relation of the demographics and transportation system in Cincinnati to generate vector drawings needed for laser cutting. ²

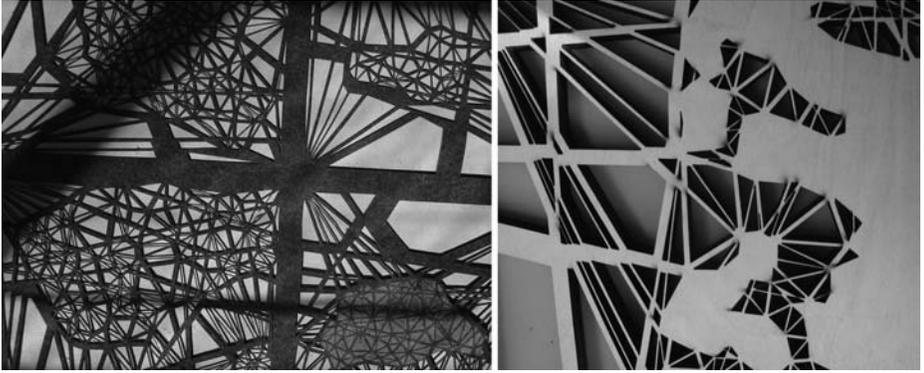


Figure 4: Left: Using synthetic felt with a fill layer. Right: GIS driven pattern cut on 1/2" Birch plywood. ³

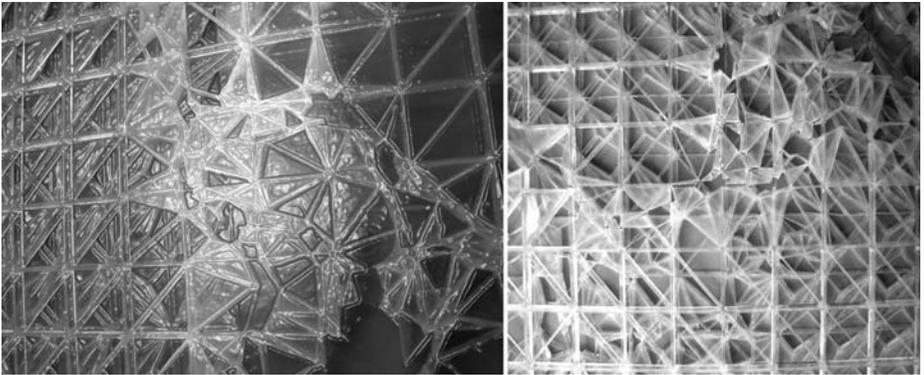


Figure 5: Acrylic panels produced based on Cincinnati transportation data. ⁴

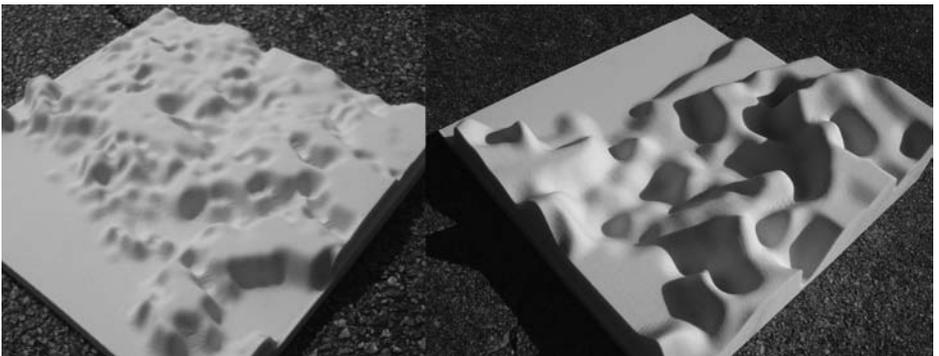


Figure 6. After transferring family income data into a 3D surface, the form was sent out to Power Mill and then milled with three axes CNC. ⁵

Fabricating, assembling, and interacting with a 3D physical model are the unique experiences that designers will never be able to achieve by viewing an abstract GIS map. The physical model became a representation of the dynamic relationship among GIS data sets. The objective was to physically realizing selected iteration(s) rather than exercising the fabrication technique. Multiple laser cut boards were overlaid and produced composed layering effects just like GIS program. The cut off material can be analyzed and even reused to build a new model that highlights inversed relationships. The marriage between GIS and fabrication technologies stimulates a different mindset and design thinking process. The dimensional and physical model becomes an object that not only represents the combination of various GIS data sets, but also displays the unseen spatial pattern and sparked the unique design solutions (Figure 6).

This fabrication process is not just a three dimensional realization of the digital forms because it does not focus on the craftsmanship or prototyping as the conventional fabrication does. It is through the digitally fabricated artifacts that we begin to observe, touch, and interact with the GIS data set and examine their correlations physically. The researchers view the artifacts as diagrammatic forms related with building facades, street layouts, and master plans with zoned clusters. Because of the parametric control of the entire workflow, the researchers are able to generate many physical iterations in a relatively short period of time. It is the interplay between the digital and the physical that this idea of *information urbanism* develops possibilities that are empowering and justified.

3.SWARM CITY

Swarm City is one of our experiments exploring how to use the diagrammatic geo-spatial data to automatically construct a highly detailed urban model for a video game. The entire city was generated out of a network of parameters. The goal is to simulate the possible form of urban fabric, a “wet grid” described by Frei Otto, a diagram city, which grows from a complex social pattern, rather than following an imposing neutral gridiron pattern. The complex urban fabric relies on how individual building’s parameters, such as dimension, FAR, roof slop, window to wall ratio, respond to the landscape features such as contour, vegetation, and view shed. A tool named “City Generator” has been developed based on the Generic Evolution computation using procedural model and GIS map. In the first phase, *City Generator* is used to “breed” selected architectural models across several generations. In the second phase, *City Generator* uses 2D maps to generate 3D spatial occupancy (SO) model. These 2D maps contain GIS data, which reflect zoning, population, transportation, and other spatial information. In the final phase, each voxel in the SO model of Phase II is substituted by a detailed procedural building model survived in Phase I. The substitution rule is defined by the designer according to design criteria. For instance, a view-shed map is created based on GIS digital elevation model (DEM) to control the placement of building’s orientation. A family income map is used to control the placement of particular building style, height and façade feature. A population density map is used to control the placement of community centers and public space. A DEM map is generated to move all buildings up and down following the contour lines. These maps contain information to parametrically control thousands of building typology to morph gradually. “Expressions are altered and various spatial arrangements are produced as the information input is switched.” (Tang, 2007) Here, the concept of information urbanism provides the engine to auto-construct the city based on simple rules and logics (Figure 7).

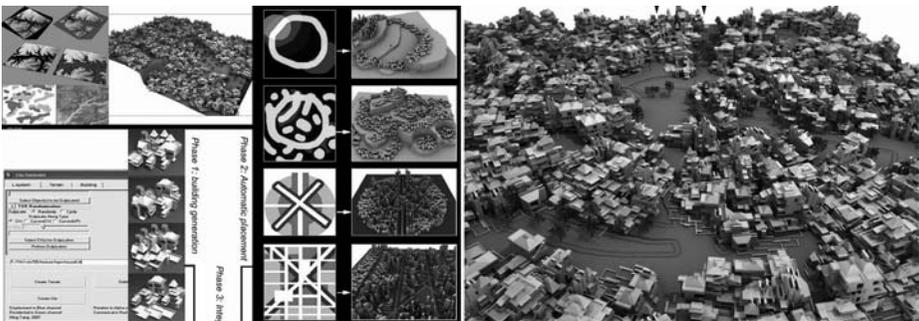


Figure 7. Swarm City Project. GIS driven parametric urban model.

4.CONCLUSION

Through the research and teaching, our intension is to use the demographical, social spatial data as forces to control both urban layouts and individual building's parameter. Here, morphological output variables can be programmed to respond to environmental input parameters. This interactive relationship can be even realized in a much smaller scale like glazing panels and shading devices, "As the system of shading elements wraps around the façade the spacing, shape and orientation of the individual elements gradually transform and adapt to the specific exposure conditions of their respective location on the façade. The result is a gradient, continuously changing façade pattern that optimizes sun-protection relative to light intake for each point on the façade" (Schumacher 2010). As the parametrisation can be applied in all the design scales, from micro to macro, large scale *information urbanism* can be used to control the detailed building style as well.

We believe the geospatial database can provide a rich resource to optimize urban forms with respect to ecological performance criteria. The demographic, traffic, economic data from GIS provides the trace of activity and event parameters of the urban life process. As Schumacher described in the *parametric city*, "parametricist continuation is always possible in myriad, unpredictable, and qualitatively diverse ways, but it is never random" (Schumacher, 2010). Different from traditional urban design process, the *information urbanism* provides us a range of abstracted urban diagram, rather than a particular design solution. In another word, the outcome of *information urbanism* is the consistently morphing forms driven by the changing relationship of information, which can be interpolated into physical landscape features. As Kokkugia team has claimed 'Our urban design methodology does not seek to find a single optimum solution but rather a dynamically stable state that feeds off the instabilities of the relations that comprise it.' (Leach 2010)

The value of parameterize urban information, realize the 3D form, either conceptual or diagrammatic, through digital computation and fabrication became a valuable teaching and research method in architectural and urban design field. It created an interesting notion to the parametric urbanism practice and further exploited the idea that design practice begins with the information. This ongoing research is now focusing on how to organize and share the open source script to the research community and continue the collective study to build a bridge between GIS database and parametric urbanism theories.

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ENDNOTES

- ¹Projects from Independent study. Fall 2010. Students: Enrique Sanchez. University of Cincinnati
- ¹Projects from ELDS 306, Summer 2010. Students: Johnson, Natalie; Lueders, William.; Alamri, Abdulghadir; Bakarman, Mohammed; Bindajam, Ahmed; Davis, Jarrett; Shareef, Muhammad; Su, Yang; Warren, Ryan. Savannah College of Art and Design.
- ²Projects from Independent study. Fall 2010. Students: Enrique Sanchez. University of Cincinnati
- ³Projects from Independent study. Fall 2010. Students: Steve Stidham. University of Cincinnati
- ⁴Projects from Independent study. Fall 2010. Students: Michael Zhao. University of Cincinnati
- ⁵Projects from ELDS 306, Summer 2010. Students: Johnson, Natalie; Lueders, William.; Alamri, Abdulghadir; Bakarman, Mohammed; Bindajam, Ahmed; Davis, Jarrett; Shareef, Muhammad; Su, Yang; Warren, Ryan. Savannah College of Art and Design.

Utilizing Virtual Reality for Simulating the Auditory Perception In Architectural Designed Spaces

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ABSTRACT:

Rapid development in computer technology has triggered the emergence of new methods and techniques for room acoustics simulations. However, the auditory representation of a simulated space is usually given less attention than the visual representation. This paper demonstrates an approach for simulating the auditory perception in architectural spaces based on auralization, utilizing an immersive virtual computer-generated environment. Detail steps in this approach are provided including the process to transform two-dimensional drawings into room acoustics simulation. Change in the auditory perceptions in an architectural space with variety of design implementations, were recognized. Spatial perception of distance and orientation were explored while architectural elements and acoustical properties of the surfaces were changed with the goal to obtain the anticipated room acoustics quality. While multidimensional virtual environment provides the ability to investigate the visual and auditory perception simultaneously, this approach provides the ability to present computer generated spaces, synthesize auditory events and have users experiencing the architectural design impact. Evaluation of the room acoustics, given the architectural design options can be done at any stage of the design process.

CONFERENCE THEME: On Approaches, Digital Approaches and the "Real World"

KEYWORDS: virtual reality, auditory perception, room acoustics, simulation, auralization.

INTRODUCTION

Architectural space can be described as a three dimensional extension of the world around us, the distances and relationships among people, people and objects, and or between objects (Altman 1980). The three dimensional space is created to serve certain functions and being experience by human senses. Auditory is relevant to the sense of hearing, which involves three elements: 1) the physical nature of the signal, 2) the sensory detection by the nervous system, and 3) the final transformation into a perception. Research in architectural design utilizing virtual environment system has focused on visualization, while relatively little attention to auralization (i.e., rendering spatialized sound based on acoustical modelling). Spatialized sound is important in immersive virtual environment applications since it aids visual ability for localization of objects, separation of simultaneous sound signals, and formation of spatial impressions of an environment (Blauert, 1997). Experiments have shown that more accurate acoustic modelling provides a user with a stronger sense of presence in virtual environments (Durlach, N.I. and Mavor, A.S., 1995). Limitation in visual cueing when objects are outside a user's field of view is overcome with the use of auditory cues. The complexity of virtual environments varies from scenery of enormous objects, buildings, and streets with multiple auditory events to simple spaces with a simple beacon. Visual and auditory stimuli are the primary digital components in providing the human interaction interface. Factors governing the integration of these stimuli into virtual reality (VR) applications particularly to enhance human cognition can be found in references (Suied, Bonneel et al. 2008; Lauter, Mathukutty et al. 2009).

Basic methods and techniques for auditory representation in virtual environment to construct a spatial perception of the VR are provided within this paper. It relies on the simulation of the sound propagation, auralization and auditory reproduction. A brief description of research methods in room acoustics helps to understand the research objectives. The paper focuses on current auralization techniques that use input from computer simulation. Currently, research in this topic is leading to a real-time auralization for dynamic auditory experience within the virtual space (Lentz et al, 2007).

I. RESEARCH METHODS IN ROOM ACOUSTICS

The interrelationship between the room acoustics objective parameters, subjective responses of the listeners and the architectural design strategies have lead to the development of various methods for room acoustics. Research objectives may include diagnostic of the real-space, provide design improvements and evaluation of the design. A brief description about research methods applied in room acoustics is shown in Figure 1. Majority of the techniques are relying on quantifying the acoustical quality using objective parameters calculated from impulse responses. An impulse response is the time response created by the overall sound waves that travels from a source to a receiver along a multitude of propagation paths. Objective parameters measured are then correlated with subjective indices. Given the analysis and interpretation of data from objective and subjective measurements, the room or space is characterize as acoustically desirable or undesirable. Choosing the appropriate method is the key strategy to obtain an optimum design solution.

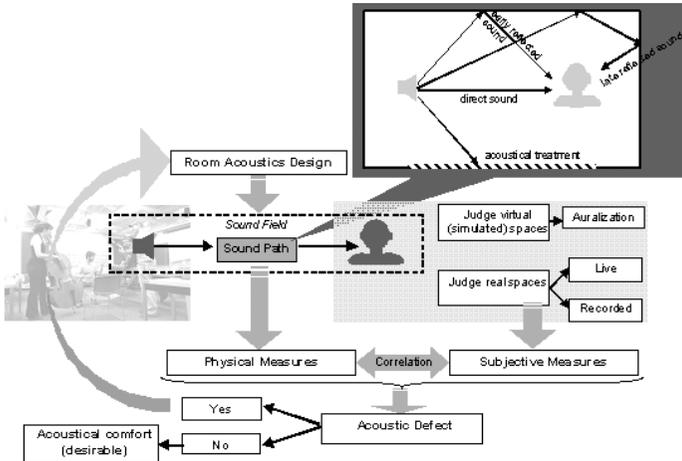


Figure 1. Research in room acoustics design

2. ACOUSTICAL MODELLING

The auditory representation of a virtual space can be synthesized by using three operational parts: sound-field modelling, auralization, and auditory reproduction techniques. The most common computational methods for simulating the propagation of sound through an environment is based on geometrical acoustic modelling (e.g. image source methods, ray tracing, and beam tracing). Many acoustic simulation software are using the combination of ray tracing and image source methods. The source emission patterns, atmospheric scattering, surface reflectance, edge diffraction, and receiver sensitivity for sound waves travelling along each path must be defined as mathematical objects. Acoustic characterization of surfaces are based upon absorption and scattering coefficients.

The acoustical modelling process may vary depends on the complexity of the space geometry and its architectural elements. It is due to the need of a sufficient number of sound rays in order to obtain a reliable computational result. Although, simplification of the modelling reduces the computational time, it also has a downside to the numerical results (Vorlander, 2008; Zeng, X., et al., 2006). A valid approximation for room acoustics simulation is by treating the sound sources as omni-directional point sources since it provides the opportunity to obtain the acoustical impacts from all surfaces. Sound energy profile of a computer simulated impulse response can be quite different with impulse response obtained from measurement in the real-space (Astolfi, 2005; Astolfi et al., 2008). Several attempts however, have been done to eliminate these differences by improvements in the techniques and simulation algorithm (Wang and Vigeant, 2007). Steps required within the acoustical modelling and computer simulation process is described in Figure 2, using a recording studio as an example of the architectural space observed.

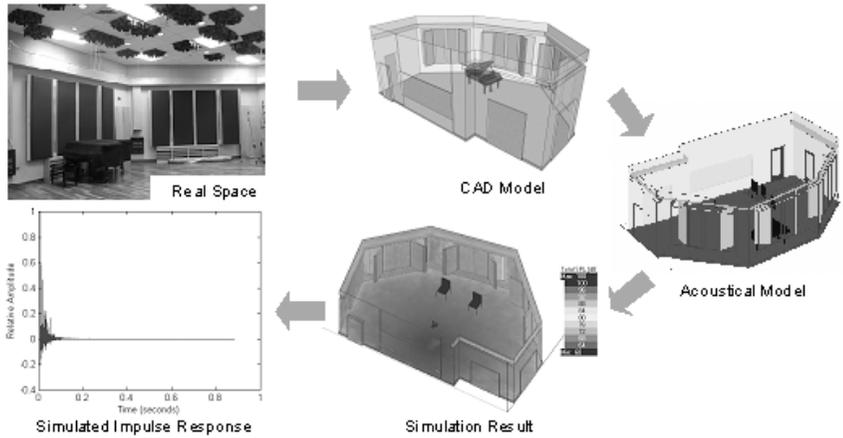


Figure 2. Acoustical modelling and computer simulation process

3. AUDITORY PERCEPTION AND AURALIZATION

Sound waves are being reflected, absorbed, and transmitted as they propagate through an environment. The portion of it being detected by the hearing system is known as the auditory event, which is responsible in creating the auditory perception (Blesser, 2006). Auditory processing by the human brain allows sound to have variety of pitch and loudness (Howard and Angus, 2006). Any objective parameters derived from impulse response measurement in the room of interest can represent average impression of the room acoustics (see Figure 2). However, the auditory event is only covered through a full auditory experience by on site evaluation or by auralization. Detail steps from computer simulation to subjective evaluation of the acoustical condition utilizing VR is described in Figure 3.

Subjective evaluation of real space are having subjects seated in the room and listen to the auditory stimuli while in auralization, subjects listen to audible numerical (simulated, measured, synthesized) data that represent the actual acoustic conditions, without being seated in the real space. General overviews of the auralization can be found in references (Kleiner, M. D., et al., 1993; Lehnert and Blauert 1992).

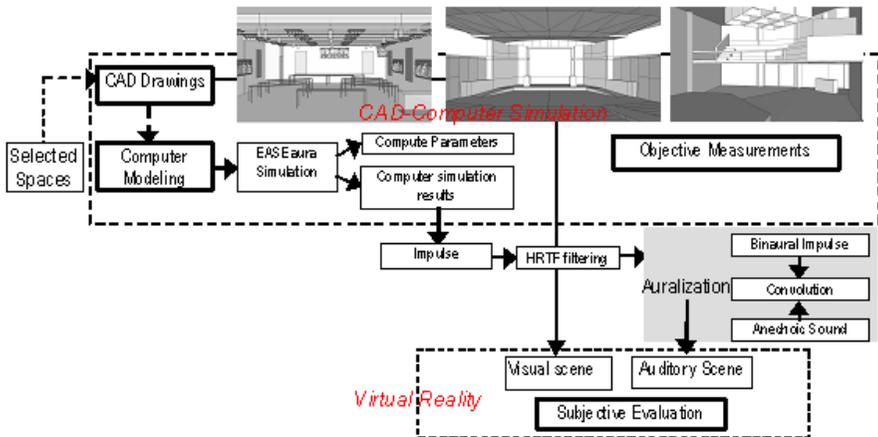


Figure 3. Methods and techniques applied for subjective evaluation of virtual spaces

Using a simulated impulse response and a sound recorded in an anechoic space enables to generate the auditory representation of a virtual space through a signal processing technique known as convolution (Vorlander, 1989). It is the main process in auralization. More advanced techniques which provides ability for real-time auralization have been developed by others (Funkhouser, Carlbom et al. 1999; Lentz et al., 2007). Some have studied the selections of system and technology based on physical design criteria for various applications such as navigation aids, virtual control rooms, integrated multi-modal virtual environment generators, and psychophysical research (Sahrhage 1999; T. Lokki 2000).

The final stage of auralization is reproducing a three-dimensional (3D) sound field for the listener. The sound reproduction utilizes 3D auditory display techniques that can be classified as: 1) binaural and transaural techniques, focuses on recreating the sound field at both ears of the listener using headphones (binaural) or loudspeakers (transaural) and 2) multi-channel auditory displays, construct 3D sound field using an array of loudspeakers. Auditory reproduction through headphones requires a further signal processing for simulating and auralizing impulse response. The delay time of the sound arriving at the left and right ear and sound scattering due to the head, ear pinna, and upper torso should be considered. This process creates a realistic condition as if the room impulse response (RIR) is recorded at the human ears. The transformation of sound-field cues into cues at both the human ear drums can be modelled using binaural technology (Lehnert and Blauert 1992). An algorithm transforms a room impulse response (RIR) into a binaural room impulse response (BRIR) utilizing the head relative transfer function (HRTF). The ability to compare and interpret the time lag between the sounds reaching the right ear versus the left ear provides the localization cues (Zwicker and Fastl, 1999).

4. ACOUSTICAL CONDITION OF THE CAVE

Application of the approach in this paper emphasized on subjective evaluation utilizing digital data with Cave Automatic Virtual Environment (CAVE) system. It is an immersive VR environment system provided in the University of Michigan 3D Lab facility (<http://um3d.dc.umich.edu/>). Projectors are directed to four projector screens including the floor of a room-sized cube.

4.1. OBJECTIVE MEASUREMENT

An objective measurement of the CAVE facility was conducted utilizing Acoustics camera, a system of multi-microphones arrays based on beam-forming with acoustical imaging algorithms. The background noise level, reverberation time and the loudspeakers performance are the variables measured. Noise image mapping of the CAVE surfaces shown in Figure 4 is used to observe the reflection paths and the directionality of the sound energy coming out from the loudspeakers. The sound recorded by the microphones are shown in the upper bar of the noise image mapping. Colour mappings on the CAVE surfaces are indicating total loudness level (in dB) that arrived at the microphones due to the direct and reflected sounds. The legend interprets the range of loudness level.

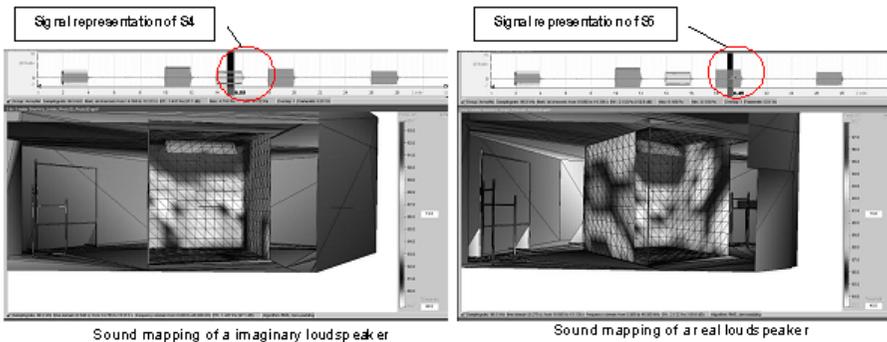


Figure 4. Mapping of the sound propagated inside the CAVE based on Acoustics Camera measurement

Computers, projectors and other electronic devices were producing high ambient noise level and it exceeded 40 dB during the measurement. The average reverberation time (T60) was in the range of 0.5-0.6 seconds. Performances of the loudspeakers were evaluated by displaying a recorded sound of a Mozart's string quartet piece at 8 locations within the virtual space. These positions are shown in **Figure 5** presented in the following section. Source 1, 3, 5, and 7 in the virtual space were matched to the positions of the loudspeakers in the real space.

4.2. LOCALIZATION OF THE CAVE VIRTUAL SOURCES

For VR applications, the auditory display devices should be able to provide 3D localization cues. The signal received at the ears is influenced by all the signals transmitted from the auditory display device together with the transformation that the signal undergoes as it propagates through the sound path. Nine subjects were brought into the CAVE and experience the auditory stimuli that were reproduced in sequence from four loudspeakers (see **Figure 5**). The recorded sounds used as the stimuli were the same with the ones used in the objective measurement.

By using a laser pointer, subjects indicated the locations where the auditory sources were perceived. The process was recorded and results of the laser points are represented on a 3D drawings of the CAVE with the grid scene as shown in **Figure 5**. Given the high background noise level, subjects within the cubical space were still able to locate the sound sources. The results show that all the sound sources in the virtual space are able to be identified and localized both from the objective measurement and subjective testing.

5. NEW APPROACH AND ITS IMPLEMENTATION AS AN EXAMPLE OF WORK

As mentioned earlier, the application of this approach is for subjective evaluation in room acoustics. The main objective was to understand the impact of diffuser which has become a trend in room acoustics design solution. A recording studio is used as an example of work. Diffusion is considered as an effective acoustic treatment in this type of room to control reverberation by breaking the reflected sound energy into several directions. An object that creates diffusion can be categorized as diffuser. However, acoustical panels labelled as diffusers in practice, might not be the critical element that creates the major diffusion within the sound field. Room size, amount of absorber, diffuser and space layout of variety of architectural spaces are some other variables needed to be study.

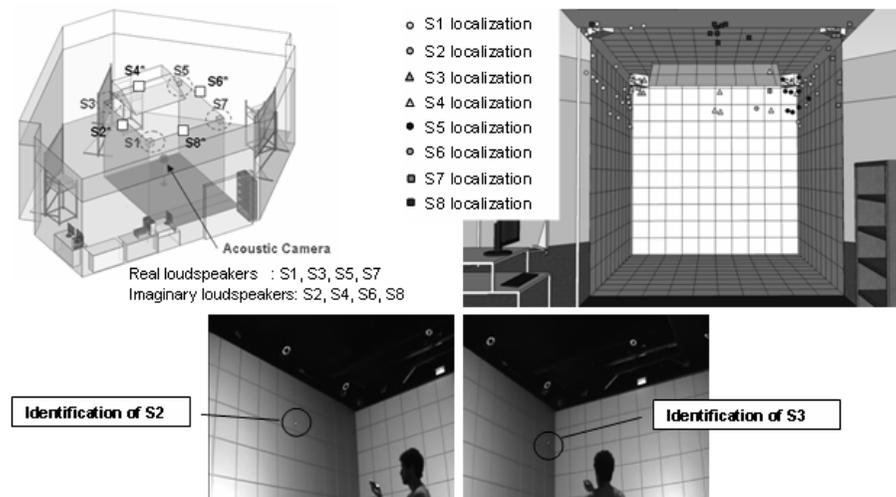


Figure 5. Subjective testing in the CAVE to localize sound sources of the virtual space

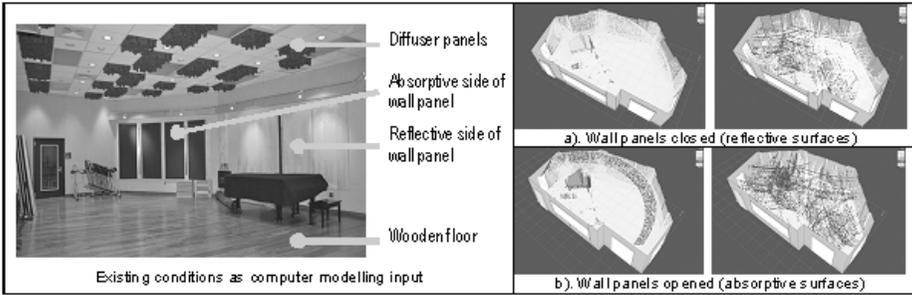


Figure 6. Existing conditions and simulation of the propagated sound waves utilizing ray tracing.

Based on measurements in the actual space and room acoustics computer simulation, several architectural elements were changed. The elements were adjustable two-sided absorptive and reflective panels, diffuser panels on ceiling, and the presence of piano as part of interior layout. The auditory events within these spaces generated from the auralization were expected to be different, particularly in spaces where the objective parameters indicated significant differences.

The architectural elements used as part of the design parameters are shown in Figure 6. Two different space conditions where the adjustable wall panels were positioned as opened and closed are compared using ray tracing techniques. This simulation indicates early and late reflections based on the propagated sound energy due to the amount of absorptions and or reflections from the surfaces of the wall panels.

Before the auditory stimuli was brought into the CAVE, a subjective test was done utilizing computer interface. This included, an investigation of noticeable differences of the recording studio with two conditions, both having the same diffusers and wall panels but with and without piano presence. Subjects listened to two auditory stimuli which correspond to those two space conditions. Subjects were then asked which was the sound that they perceived coming more from their left side. From 28 subjects, 27 of them indicated that the stimulus recorded inside the recording studio without piano is correctly heard from the left side. The results show that piano impacts sound localization. This impact was due to early reflections that interferes with the direct sound. There were differences in the auditory perception within these spaces while no significant difference was shown by the objective parameters. Details of the survey questionnaire and the subject responses is shown in Table 1. Results from auralization as auditory stimuli were utilized for subjective testing to register the auditory perception on the loudness within the degree of just noticeable differences. The clarity and liveliness (echoes) of the room were also investigated.

Auditory stimuli used within the CAVE are wave formatted data files within the sound system capabilities for a given listener's position. In an attempt to evaluate the auditory representation of a designed space, subjects were located at the same position for their selected visual and auditory scene.

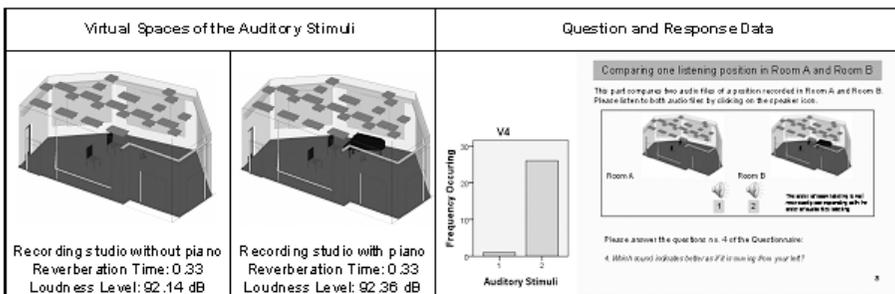


Table 1. Example of a questionnaire for an auditory perception survey utilizing auralization.

This enables one to experience and interpret the room acoustic conditions before and after the design changed. Assessment of the subjective response within the CAVE requires different survey techniques than the one described in Table 1. The use of real time feedback data collection system provides a new alternative to capture the user reaction to a given visual and auditory cue simultaneously. The subject recognition of the sound quality and its room acoustic characteristic may be different with and without the visual stimuli. The advantage of this integrated simulating techniques within virtual environments helps to accelerate decision making during the design process. The following examples are an attempt to show the application of such techniques that combine auralization and CAD computer modelling which include the visual scene information. To experience the 3D-Sound within the recording studio for its architectural features, the sound intensity were measured using



Figure 7. Simulated visual and audio scenes for a recording studio within the CAVE

Acoustic camera system utilizing beam-forming technique and the measured scene were saved in a WRL formatted file. It was then displayed within the CAVE environments. Figure 7 shows the visual representation as overlaid with the acoustical data (acoustical image) obtained from field measurement in the real-space. Table 2 provides an example of the parametric details, architectural configurations and auralization signal representations. This example of work demonstrates the major steps to be considered when utilizing this proposed approach. The true sound representation through its correct auralization combined with head related transfer function as displayed with headphones provides the most realistic feed back from the users. When the research objectives and the questionnaires within a given survey techniques are integrated, then the most reliable results are possible to obtain while using the CAVE or VR system.

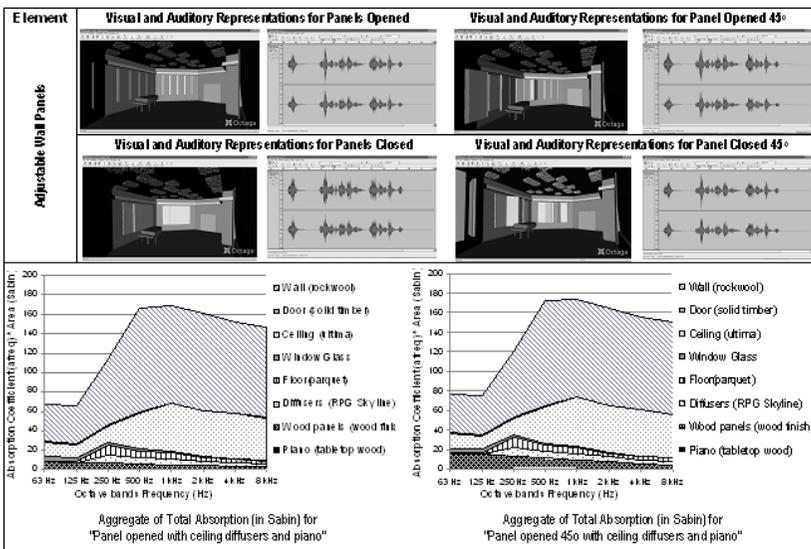


Table 2. Representation of the auditory and visual rendering of the design variations in the recording studio.

CONCLUSION

Given the recommended path within this proposed approach; it is now possible to generate auditory stimuli and eliminate errors during the auditory reproduction in VR applications. Measurements in the CAVE facility, both objectively and subjectively, have shown a relatively high background noise and other acoustical impacts which requires the use of advance headphones system. The subjective testing results for spatial auditory perception are therefore, strongly related to the quality of binaural impulse response as integrated with the quality of acoustical modelling. Choosing the appropriate auditory display devices is also a key factor. In practice, application of this new approach requires basic knowledge of 3D acoustic modelling and experience in room acoustics computation along with signal processing. Depending on the room acoustics properties, results have shown that complex models with some degree of details are necessary or required to address a particular research question. This was shown in the investigation on the piano presence and its impact to the acoustical condition of the recording studio. However, it is important to consider the trade-off between accuracy and computational time since this approach involves many sound signal processing steps and algorithms that are capable to handle architectural complexity as required within the field of audio engineering.

Once an auditory stimuli with an accurate representation of the virtual space is obtained, the challenge is on the experimental setup for the subjective testing. Direct involvement from the researcher in the CAVE and associated technology is often required. Given the visualization of the space and auralization of the auditory stimuli, users can experience the multi-dimensional environment using visual and auditory senses simultaneously. This ability may help architects and designers to accelerate the design decision making process.

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Concretion, abstraction: the place of materials in architectural design processes.

Case study: Peter Zumthor

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ABSTRACT:

Today the design processes are fundamental for the understanding of architectural projects, since universal rules of composition (harmony) and common ideals (beauty) have failed to support them exhaustively. A possible stable common ground to all constructed projects remains in the act of construction.

Peter Zumthor's work is representative of this new framework. In his designs, he explores synergies between the abstract paper work and the concrete constructive realities. When explaining his projects, he highlights the design process which encompasses the abstraction, the materiality and the reality.

This paper bears relevance for both practitioners and theorists at two levels: it explores the theoretical relevance and the practical tools of an outstanding referential architect. It explores, with the specific tools of the architect, the design process of his projects through the question of materials. The analysis is based on both his writings and his realized projects.

CONFERENCE THEME: Select one of the ARCC major conference categories

KEYWORDS: materials, design processes, construction, Zumthor

INTRODUCTION

I began this research when I was in charge of the construction lesson at the UCL (Université Catholique de Louvain). I realized that my students did not have access to an important part of the architectural profession. They could not measure the importance of materials and their use in the conception process of the project. Therefore I based my teaching on case studies. Doing this, I noticed that the design practice today operates more by "examples" than by general understanding. When considering examples, designers are confronted with a tension between reproduction and differentiation (they take over interesting features but also need to innovate). Through the understanding of contemporary architect's practices, it might be possible to identify some usable tools or principles that enable an open evolution of practices without constraining them into preestablished moulds.

Observing contemporary architecture, as a practitioner and teacher, one becomes aware of the difficulty to understand the constitutive rules of a project and even when one can identify some, they are often unique and unshared. The qualifiers for the word architecture have multiplied over time: minimalism, hygienism, socio-participationism, formalism, high-tech, low-tech, sustainable and eco are some examples. After one century of avant-gardes, architectural practice has been scattered in uncountable styles and streams. This has led to a free market situation in which architects are confronted by an almost endless catalogue of approaches and styles: between multiple-choice and pragmatist refusal, this context provokes an issue with arbitrariness and relevance. This is probably not an isolated phenomenon. The deconstruction of the architectural design field certainly has its counterparts in other artistic disciplines.

My thinking is fuelled by my cultural position as a European French speaking architect and teacher of architecture.

Jacques Lucan in “On en veut à la composition” (Jacques Lucan, 2002) makes the assumption that the term composition is no longer able to describe the architectural design process. He affirms that architecture does not respond anymore to compositional logics and objectives that make the necessary correspondence of the parts in the unity of the whole the understanding key of architecture. The issue of composition has always played a central role in architectural theory. According to Jacques Lucan, the traditional relationships between the parts ensuring the unity of the whole, which are embodied in the compositional rules and objectives, fail to give an exhaustive account of most contemporary design processes.

To understand the loss of universal rules (composition) and common ideal (beauty), we can refer to the conference of Bernard Huet “Sur un état de la théorie de l’architecture du XXème siècle” (Bernard Huet, 2003).

Vitruvius, Alberti and architecture theorists, who have followed them, do not make the distinction between architecture and the art of construction. The architect is omniscient and proficient in all disciplines. Traditionally, the architectural treatises are articulated in four parts, no matter how many books they consist of. A first part defines and outlines what architecture is. In this part, the author positions himself in the field of the existing treatises. The other 3 parts redefine or actualize the Vitruvian categories: firmitas (solidity: construction and architecture), venustas (beauty: how to compose) and commoditas (utility: what architecture is for architecture). Until the eighteenth century, it was around these common themes that the architectural debate was being built. A first rupture happened with the affirmation of Boullée, stating : “Vitruvius is wrong, there are two parts in the architecture, there is art and science and only art, i.e. Art, not the art of building; only art falls under the area of architecture” (Etienne-Louis Boullée, 1968) . For Boullée, Architecture lied in the project itself and not in the built reality. The unity of the Vitruvian trilogy was broken apart.

One can note that this epistemological shift coincided with the appearance of the first engineering schools in France (Ecole Nationale des Ponts et Chaussées was founded in 1747 by Jean-Rodolphe Peronnet following a royal decree). The outbreak of engineering schools fundamentally changed the construction field. The appearance of tender offers and constructive details caused the disempowerment of craftsmen.

This implied a gradual dislocation of the profession of the architect and of the craftsmen, who lost control over some parts of their field, which were based on tradition, and were now confronted with the integration of a group of specialists into the design process.

The nineteenth century and the industrial revolution confirmed the role of engineers by the apparition of new materials such as steel and reinforced concrete, modifying deeply the construction field. This epistemological shift pushed theorists to reinterpret architecture from the Antiquity and of the Middle-Age. This new knowledge questioned the composition processes. Viollet-le-Duc and Gottfried Semper were the first to actualize the rupture of the Vitruvian trilogy in theory and in practice. Viollet-le-Duc proposed a theory based on the art of construction itself, in which spatiality was the result of a structural or constructive principle. On the other hand, Gottfried Semper proposed a theory in which spatiality was realized through the disposition of skins (“*Prinzip der Bekleidung*”). Structure and construction became spatially irrelevant and hidden necessities.

Since then, the Vitruvian categories can be thought separately. This has widened the field of research in architecture considerably and was echoed by “engineer architecture», represented in France at the end of the 19th century by architects like La Brouste and A. Perret. Since the beginning of the 20th century, the avant-garde experiments of the functionalist, formalist and constructivist architects developed the dislocation of the Vitruvian trilogy further. Their projects were mainly directed to one single Vitruvian category and marginalize the other two. Since the end of the 20th century, the freedom made possible by the Vitruvian dislocation seemed to question fundamentally architectural processes. A shift from a coercitive traditional unity towards a libertarian specialized dislocation had taken place. Are there still recognizable principles inherent to architectural processes? Are there still identifiable endogenous dimensions of architecture?

It is noticeable that nowadays built projects must meet an amount of rules located outside the field of architecture (urban planning, safety, firefighter, budget, image or marketing...) that dislocate

the profession even further. As a practitioner, one can question if there are still common “codes” for architects? Many architects “who build” offer a specific approach to the act of building, as if this was an inalienable aspect of architecture feeding it from the first sketches. I propose that a possible stable ground to all built projects remains in the act of construction. Here I would like to overcome the theoretical “skin-structure” debate induced by Viollet-le-Duc and Gottfried Semper, in order to focus on the making of architecture.

CASE STUDY: PETER ZUMTHOR

Peter Zumthor’s work is representative of this new (absence of) framework. In his designs, he explores synergies between the abstract paper work and the concrete constructive realities. When he explains his projects, he highlights his design process which encompasses abstraction, materiality and reality. Particular interesting in his work is the relationship between tradition and its surpassing.

The following analysis is based on both his writings and his realized projects. To date, Peter Zumthor has held several conferences. The following reflection is based on “Thinking architecture” and “Atmosphere”, two texts that have followed these conferences.

In the first place, it is important to recall that Zumthor had trained as a cabinetmaker before studying architecture. Before starting his own architecture practice, he worked several years at the department for preservation of monuments in the canton of Graubunden in Switzerland.

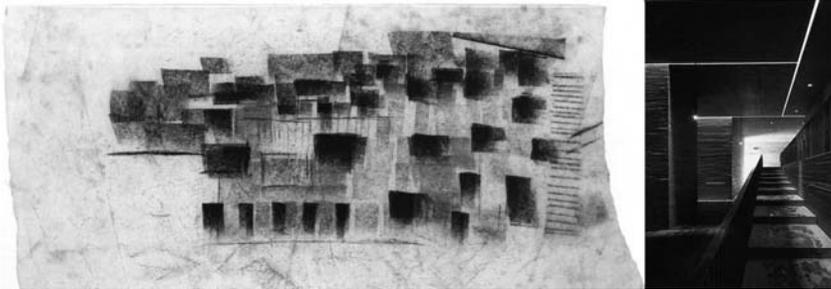


Figure 1: drawing and picture thermal bath, Vals (Peter Zumthor, 2007)

I. ATMOSPHERE

Zumthor describes his architectural goals as following:

When I work on a design I allow myself to be guided by images and moods that I remember and can relate to the kind of architecture I am looking for. (Peter Zumthor, 1998, 25)

Entering a Zumthor building, one is instantly caught in a particular atmosphere, by an immediate emotion. Peter Zumthor searches in his memory for images and architectural sensations in order to create the atmospheres that are implemented in his projects. Rather than implying an intellectual meaning, he creates an immediate and physical relation to the environment to space as to the material, to heat and light, as well as sounds and smell. What is the particularity of the atmospheres of Zumthor’s buildings?

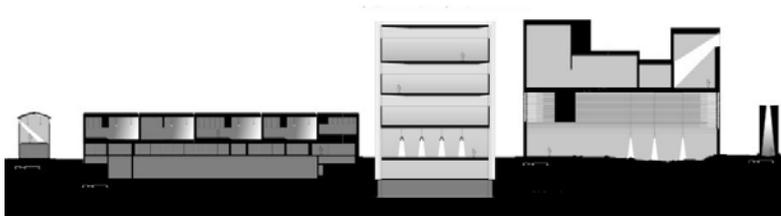


Figure 2: Spatial analysis of Saint Benedict chapel, Vals Therme, Bregenz museum, Kolumba museum, Brother Claus chapel

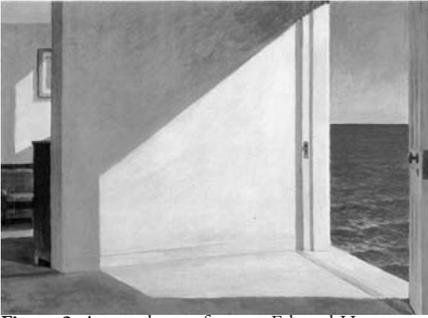


Figure 3: Atmosphere reference: Edward Hopper, rooms by the sea, 1951

1.1. SPATIALITY

Monumental scale, indirect or diffuse light and interiority are three spatial features used recurrently by Zumthor to create his peculiar atmospheres. All these features confer a sacred expression to spaces.

Pronounced contrast appears between light and shadowy areas. One can distinguish two light modes. First of all, light can be channeled in order to create light and darker areas. This implies that the light source is always “elsewhere”, inducing complementarily light shades in the space. Good examples for this are the chapel Bruder Klaus and chapel Saint Benedict, Vals thermals baths, Kolumba museum superior rooms. Secondly, shadow and light can be defined diffusely, often by a shadowy ceiling zone as it is the case, in the ruins of Chur, the Bregenz Museum, or the Kolumba museum ground floor level of the ruins. Here, the light is diffused through the facade, acting as a filter. Low pending artificial light emphasizes the contrast, creating a light space within darker architectural spaces. The architecture sets the lighting conditions, which on the other hand define the perception of space (e.g. Fig 2). This can be considered as a transformation of Le Corbusier’s quote “Architecture is the learned game, correct and magnificent, of forms assembled in the light”. Zumthor induces a reciprocity between light and architecture.

Monumentality is introduced by scale effects and high ceilings. The absolute absence of symbols increases the sensation of eternal structures standing there for their own sake. Monumentality corresponds to a-humanity, as it often seems that Zumthor’s work is quite a-programmatic and not intended for appropriation.

In his projects, a distance to the outside world is established. His buildings seem to be out of space and out of time. The interaction of the outside world is always mediated. For example, an identifiable entrance system pierces the material thickness of the building’s skins. Zumthor limits the views to the exterior. This tool allows him to avoid views to the approximate context and narrows the viewing frames to the distant landscape only, even in dense building environments such as the Kolumba museum. There is also a lack of physical articulation to the context. The buildings are carefully located in the landscape in order to maintain their independence, like neolithic stones or centenary trees, but are not articulated on a material or typological basis.

Two categories of buildings appear:

The first one consists of single, isolated cells (for example: Klaus Bruder chapel, Saint Benedict chapel). These unicellular buildings share identical spatial features. Strong “chiaroscuro” affects space through natural indirect lighting, and interiority is created through an umbilical access creating a distance between the interior and the exterior world. In those unique cells, there are no views to the exterior.

The second type is characterized by complex programs that require multiple rooms. These multicellular buildings consist of a combination of cells. These cells are like a set of unicellular projects, sharing the same spatial characteristics, from the umbilical access to the type of lighting and the absence of views to the exterior. This results in a building with two complementary kinds of spaces: on the one hand, unitary static spaces and on the other hand a common space, a dynamic, circulatory space which limits are unreadable. This space establishes the only dialogue with the exterior, through windows framing the distant landscape.

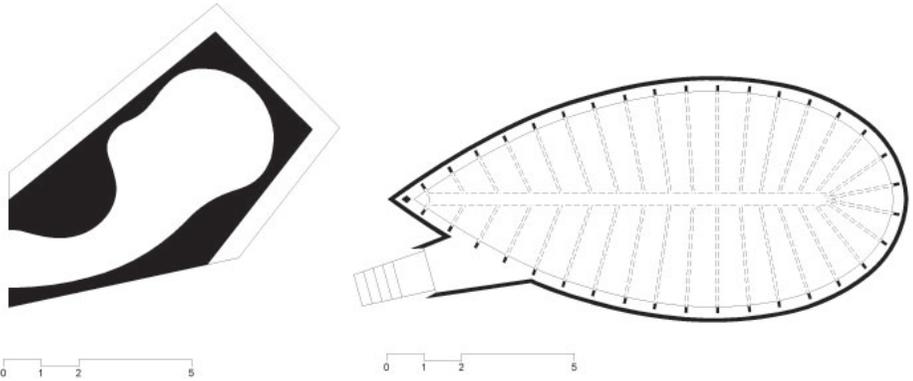


Figure 4: Plan of Brother Claus chapel, Wachendorf (Germany) and Saint Benedict chapel, Sumvitg (Swiss)

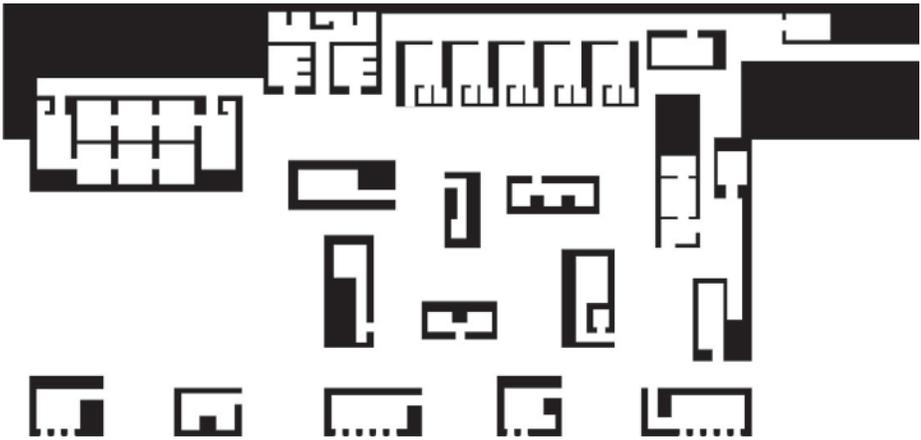


Figure 5: plan of Therme, Vals (Swiss)

1.2. KNOW-HOW

I do not work towards architecture from a theoretically defined point of departure, for I am committed to making architecture, to building, to an ideal of perfection, just as in my boyhood I used to make things according to my ideas, things that had to be just right, for reason I do not really understand. (Peter Zumthor, 1998, 35)

Zumthor considers the project as a material body, with the act of construction as underlying condition. For him, the building process is at the heart of the project's work. He was born into a family of "Handwerker" and belongs to the "Baukunst" tradition that can be defined as the architecture of the art of building. His projects always consider the construction since the first sketches and intentions. The first lines of the projects are already loaded with implications and implicitly intended for the craftsmen and the builders. This might be the reason that Zumthor's drawings are so important and specific.

According to the dictionary, know-how is practical knowledge of how to get something done. The know-how is different from other knowledge such as scientific knowledge, because it can be directly applied to a task. This is often a tacit knowledge, which means that it is difficult to transfer to another person by means of writing it down or verbalizing it. There is no universal way of transmitting it.

Zumthor obviously believes that our presence in the concrete world is fundamental and prior to any intellectual construction, similarly to what Martin Heidegger called "being-in-the world", Dasein. The concept of know-how and its application in the project lead Zumthor to stay firmly in the world of concrete and explainable things.

1.3. MATERIAL CONSTITUTION LAW

As Zumthor says, in each of his projects, the material has dictated its laws. The projects are born from an idea and in his case this idea is always accompanied by a material. He does not see a way to design in which he decides first on a shape and then on the materials.

Peter Zumthor believes that the inherent potential of materials (structural, technological, tactile, visual, etc) is best exploited by respecting their natural laws. Each project is made to fit the natural behavior of its materiality, which, in turn, is determined by assessing the project's conditions.

Matter becomes a raw potential for new constructive rules, rather than predetermined modular constructive materials assembled into a larger whole. If wood is used, it is not in the common preestablished way, but rather wooden elements are formed into a new, unique, and, at the same time, natural language. Often, various materials (each with their usual rules, are melted into one new "matter" with distinct rules, like the burned trunks and poured concrete for the Brother Claus chapel. He strives not to use the conventional morphology and grammar of architecture. "What you see is what you see" said Franck Stella, one of the artists behind American minimalism. There is no artificial message, image or symbol. He uses materials without any signification, meaning a "culturally accepted" or shared sense (this is probably to be linked with the absence of symbols in his building, cfr 1.1).

He wants to reveal the material in a similar way to American minimalism. He is particularly interested in the primary construction ("*Robbau*"). In his projects, there is no possible distinction between the primary construction (as he says "the anatomy" of the building) and the secondary layers (skins, finishes,...). The "*Robbau*" is considered as structural and technological necessity and at the same time as finishing, as one harmonic (and various ways monolithic) whole, in contrast to most contemporary architecture. It is not to be confused with an absence of finishing or a brutalism approach, because the constructive principles imply a very detailed and intended appearance. But, unlike minimalist artists, he faces other, more complex realities (program, standards, technologies, etc) that create a unique piece of art. Architecture is normally not something continuous or monolithic. It is constituted of multiple parts, often referring to different scales. The challenge is therefore for Zumthor to merge distinct elements into one single monolith. The choice of materials, their assortment and their implementation system are fundamental ingredients in the design process, together with the spatial principles enhancing a great autonomy of the building, in order to create a new, unique "construction material" from different elements, and let it develop according to its own and unique rules in an undisturbed way.

The "*Robbau*" approach of Zumthor produces three different types of monoliths.

Massive monoliths are the most obvious ones, in which the matter itself is monolithic and jointless.

Assembled monoliths appear when the elements are countable elements, like wooden elements. However, we can consider this type of building as a kind of monolith rather than a composed structure, because all elements are made to fit each other in the light of the whole. As such, every part of the structure is necessary. These structures are not strictly repetitive, meaning that parts can share features but are still unique in their shape or position.

Composite monoliths consist of two radically different elements that merge into a new, irreducible constructive method, in which the two elements are complementary and necessary to the other.

Whatever the type of monolith, they define the limit between interior and exterior. Notably, the interior side differs from the exterior side, even in massive monoliths. This bifaciality of the monoliths is interesting, because it reinforces the feeling of a complete loss of contact between the interior and the exterior, like a grotto, or a baroque church, or a treasure chest.

2. THE MATERIAL SPACE

The following three projects represent the coherence and diversity of Zumthor's approach towards spatiality and materiality.

2.1. CHAPEL SAINT BENEDICT (SUMVITG – SWISS) – THE ASSEMBLED MONOLITH

The wooden construction of the Saint Benedict Chapel is an assembled monolith, in which columns, beams, windows and the floor are clearly identifiable and separable, and solve the entire building, including the structure, cladding and the floor (except the invisible foundation).

A continuous line of natural light in the upper part of the wall separates the roof frame from the rest of the building. This light is filtered by the vertical frame. Through the high position of the opening and the thickness of the wall-structure the light source is far from the inside, reinforcing the interiority. The interior space of the chapel is defined by its ground, a wooden floor, which is also detached from the edge of the facades and structure giving the impression that the columns are coming from the soil. The lighting principle gives a monumental scale to the building.

The constructive principle is derived from “classical” wooden frames. A series of columns distributed with a short interaxial distance bear the floor and the roof. However, the classical frames are transformed into a specific shape that creates a very strong, harmonic unity. This specific shape of the roof is reminiscent of a boat hull in which each beam is based precisely on a column. The wooden windows follow the instituted rhythm, and so does the floor structure. There is a strong continuity between all elements of the building. The structure is detached from the skin, evidencing the distance “between” the place of prayer and the outside. It creates an artificial “thickness”.

The monolithic unity appears from the geometry. Although composed by independent elements, they are so complementary in form and size that their existence depends on their mutual articulation. On the outside, larch shingles contribute to the unitary character of the building. Their assembly allows a continuous deformation. The exterior skin bends to create the entrance to the chapel.



Figure 6: pictures of Saint Benedict Chapel

2.2. CHAPEL BRUDER KLAUS (WACHENDORF – GERMANY) – THE Poured MONOLITH

The chapel Bruder Klaus is entirely built in concrete.

Planted at the edge of a field, outside of the village, on a small hill, its position in the landscape can be perceived as a foreign body, or rather as a menhir present since ever. The drop-shaped plan (e.g. Fig 4) creates two spaces: a dark access corridor and a place of prayer connected to the sky. The light penetrates through a hole in the roof and through the little openings created by the wooden lagging. 112 spruce logs were used as internal shuttering. Their arrangement in tipi allows in a simple way to sustain all the effort during the pouring of the concrete. Once installed, the internal shape of the chapel is determined. The outside wooden lagging was reused as and when. Once the concrete poured, the interior wood tipi is burned, leaving the indelible trace and smell of the construction process and referring to the spirituality of the place. The finishes are included in the primary construction. The plastic of the project is intimately linked to the construction process (e.g. Fig 8).

The principle of the project forms part of its edification system. In this case, time plays a central role in the constructive process (the burning of the trunks, the layered pouring, etc.). Concrete is poured in accumulating layers, forming an indivisible mass. Although constructed of concrete only, the interior and exterior aspects of the chapel differ strongly. In the interior, the burning process of the logs has created a very different materiality giving a wooden texture to the concrete, including a wood burning smell, and darkness from the ash.



Figure 7: pictures brother Claus chapel

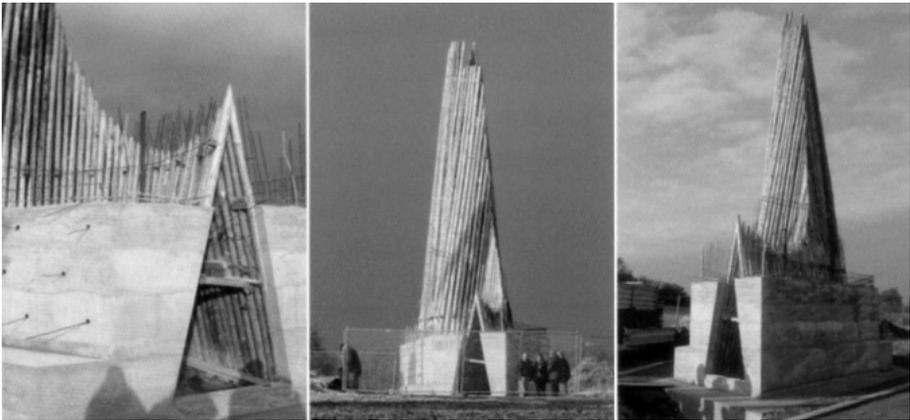


Figure 8: construction process of Brother Claus chapel

2.3.THERMAL BATH (VALS - SWISS) – THE COMPOSITE MONOLITH

The Thermal baths in Vals are a good example to reveal the subtlety of the system of joining different materials. The plan of the baths (e.g. Fig 5) is composed of different monolithic columns hosting thematic baths (flower, cold, hot, etc). Each column supports a separate roof. Light infiltrates the space through the joints of the different roofs.

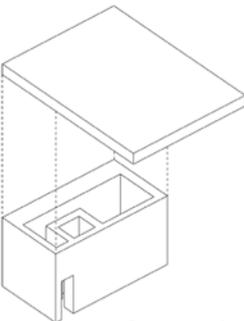


Figure 9: roof structural principle of vals Thermes

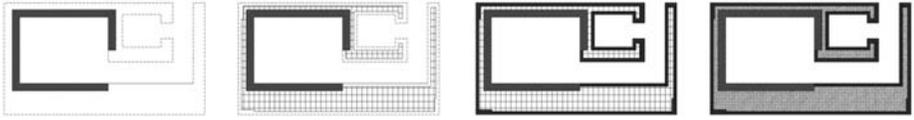


Figure 10: Constructive analysis of Zumthor, Vals baths

Peter Zumthor uses quartzite (a local stone) to confer the importance of the theme “Felsentherme”, meaning thermal bath in the rock. However, he did not use it as a simple veneer stone. To avoid this pitfall, he developed a tectonic system of mixed masonry where stone plays different roles in the structure, as a support for the implementation of the wall and finally as an exterior skin. Through this process, the shuttering are no longer simple intermediate construction elements, but they play a definitive role in a structural and visual point of view.

1. Interior walls for the bath, non-bearing, are poured on site
2. Steel bars for the reinforced concrete are placed
3. Stones of various lengths are built around the reinforcement. They form the visible part of the wall and play the role of formwork for reinforced concrete.
4. Concrete is then poured in small steps in order not to exert too much pressure on the masonry. Once charged, the masonry is requested in compression while the reinforced concrete supports the tensile strength generated by the cantilever roof.

This project is a concretion of various heterogeneous materials, forming a monolith with different materialities in the the inside and the outside of the cell.



Figure 11: interior pictures, Vals baths (A+U, 1998)

3. CONCLUSION

Despite a large material diversity (glass, concrete, wood, masonry...), his oeuvre shows great coherence.

Zumthor’s projects make use of materials arranged according to their own nature, forming harmonic monoliths with a great interiority. Zumthor explores materials, their behaviors, their internal characteristics. Then he assembles them according to their natural laws. Through the complete interiority and independence of the context, he avoids any unnatural or hybrid assembly which would not use its internal law.

He considers the building as an organism (he speaks of the anatomy of the building, with an explicit reference to the organic world) that develops according to its internal law, its behavior, its way of being. In the development of the project, Zumthor establishes the conditions for the possible state by suppressing all disturbing influences from the outside (spatial interiority). He carefully also develops the “primary assemblages” of materials and identifies precisely how they constructively behave

(material interiority). His control over the building is absolute: the constructive details as well as the spatial aspects are “closed” to external influences or contradictions, which transform the buildings into autonomous, eternal structures.

How does it relate to other architectural practices addressing materiality? Is it unique and anachronistic or meaningful for contemporary practices?

Zumthor’s position appears to be isolated. However, there are other contemporary approaches that share the fundamental idea of “the act of building” as endogenous architectural force that enables to get out of the infernal spiral of “everything is possible”

Today, we can observe several large families in the use of the materials:

The Zumthorian way proposes to respect what materials want, following their natural “folds”. He creates conditions in order to allow the materials to develop themselves without external interference through the principle of interiority. His buildings are timeless and outside of the chaotic contemporary stream of information, materials, signs and products.

The Herzog & De Meuron family question what the materials afford instead of what they want. They push materials to the limits of their capacities and twist their usual applications. Their buildings show real openness to the world. They take part in the movement of their time and put it in question, by grasping bits from the stream and torturing them to obtain some kind of truth. They operate a shift from “construction products” to “architecture’s material”, where Zumthor simply addresses the full potential of “raw materials”. Through projects such as Munich stadium (Germany), the winery in Yountville (USA) and the Tavole house (Italy), they explore the material components and reorganize them to push them beyond their internal law confronting them with reality.

The Japanese way attempts to remove materiality from architecture, following Toyo Ito, SAANA or Ishigami. In their projects, the materiality seems to become more or less absent. This absence creates a kind of timeless spatiality which is not necessarily open or closed. However, this approach is not a negation of matter (in the sense of Semper), because to make matter disappear implies a very strong commitment to materiality and very sophisticated technological solutions. Unlike Zumthor’s retraction from the contemporary fluxes by an absolute interiority, and autonomy of the crafted materials, and unlike Herzog & De Meuron, who surf and distort the wave of the industrial production, SAANA or Ishigami intend to absorb the unpredictability of the world by a transparent or absent materiality.

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