Proceedings of The ARCC Spring Research Meeting
Architectural Research Centers Consortium

Co-Sponsored by:

The College of Architecture and Urban Studies

at Virginia Tech

The Initiative for Architectural Research

Blacksburg, Virginia, April 2001

Welcome: **Paul Knox, Dean, College of Architecture and Urban Studies, Virginia Tech**

Opening Speaker, **Professor Volker Hartkopf: Director, Center for Building Performance and Diagnostics, Carnegie Mellon University.** *(We regret Professor Hartkopf did not make his remarks available for this document)*

Introduction: **Professor Frank Weiner, Head, Department of Architecture, Virginia Tech**

Plenary Speaker: **Dr. Deborah Mayo, Department of Philosophy, Virginia Tech, Author of "Error and the Growth of Experimental Knowledge."** *(We regret Professor Mayo did not make her remarks available for this document)*

Proceedings of The ARCC Spring Research Meeting
Architectural Research Centers Consortium

Co-Sponsored by:

The College of Architecture and Urban Studies
at Virginia Tech

The Initiative for Architectural Research

Please click on the paper title or speaker image to view the paper.

Can a Machine Be Trained to Reliably Report the Operational Status of Building Equipment Systems through Simply Listening? And If It Can, So What?
Paul Woods, Hoonsik Seo, Ken Parker, Richard Burt, Emmit Coots, Zeena Pinto and Seongchan Kim, Texas A&M Univ.

How E-Commerce is Changing the Facility Management Practices of Building Owners
Robert Johnson, Mark Clayton, Jeong-Han Woo, and Ge Xia, Texas A&M Univ.

New Approach for Documenting Historic Buildings
Hussein Abaza & Yvan Beliveau Virginia Tech

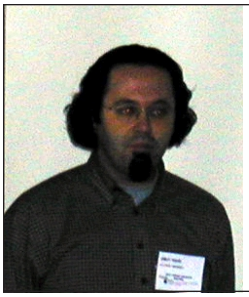
Factors That May Lead to the Prediction of the Compressive Strength of Concrete by Means of it's Sound Transmission Properties
Paul Woods, Emmit Coots, Richard Burt, and Zeena Pinto Texas A&M Univ.

Proceedings of The ARCC Spring Research Meeting
Architectural Research Centers Consortium
Co-Sponsored by:
The College of Architecture and Urban Studies
at Virginia Tech
The Initiative for Architectural Research

Transportation + Street Trees: Effect of the Urban Design Industry's Roadside Landscape Improvement Standards on Driver and Pedestrian Performance
Jody Rosenblatt Naderi, Enrique Serna, Byoung-suk Kweon, and Chris Ellis, Texas A&M Univ.

Managing Computer-Based Environmental Information
Jun Xu & James Jones Virginia Tech

Sustainable Urban Design for Asian Cities: Technological and Economic Concerns
Sivaguru Ganesan Univ. of Hong Kong



Making a Small Town Liveable: Promoting Sustainability Through a New Urbanist Approach in Mebane, North Carolina
Fatih Rifki, Umut Toker, Zeynep Genc-toker North Carolina State Univ.

Arcades: Investigating the Phenomena of an Urban Form
Nicholas B. Rajkovick & A. Kwok Univ. of Oregon

Proceedings of The ARCC Spring Research Meeting
Architectural Research Centers Consortium

Co-Sponsored by:

The College of Architecture and Urban Studies
at Virginia Tech

The Initiative for Architectural Research

Thermal Comfort in Greek Revival Houses in Texas: A Computerized Energy Simulation
Anat Geva Texas A&M Univ.

A Study of Preferences for Traditional and Modern Shopping Environments in Bangkok, Thailand: Preliminary Results *Apichoke Lekagul & Patrick Miller Virginia Tech*

Applying a Constructivist Pedagogy to Design Studio Education
Matthew Powers VA Tech

Towards a Paperless Studio
Frederick Norman Ball State Univ.

Teaching Statics and Strength of Materials Using Digital Technology
Shahin Vassigh SUNY Buffalo

Proceedings of The ARCC Spring Research Meeting
Architectural Research Centers Consortium

Co-Sponsored by:

The College of Architecture and Urban Studies

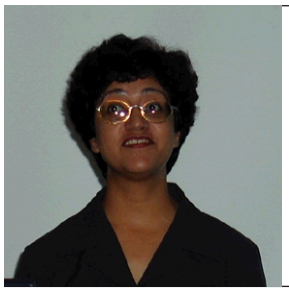
at Virginia Tech

The Initiative for Architectural Research

Ciao! Penn State: A Scaffolded Learning Environment
Darla Lindberg & Michael Halm Penn State

Blobs, wiggles, folds and distortions
Gail Peter Borden North Carolina State Univ.

Research Ideologies, Information, and Moral Dilemmas
Frances Downing/Robert Warden Texas A&M Univ.



Rituals and Bodies in Spatial Re-Construction of Past
Reena Tiwari Curtin Univ.

Capturing Design Sites for the Web: A Comparison of Photos and Drawings for Place Recording
Nancy Cheng Univ. of Oregon

Proceedings of The ARCC Spring Research Meeting
Architectural Research Centers Consortium

Co-Sponsored by:

The College of Architecture and Urban Studies

at Virginia Tech

The Initiative for Architectural Research

Architecture as a Knowledge-Based Tool: The Architectural Transformation of Workspaces
Fatih Rifki/Umut Toker North Carolina State Univ.

The Building of Research: A Center for the Study of Educational Facilities
A.J. Davis Virginia Tech

Design of the Blue Ridge Parkway: Environmental Masterpiece or Above Average Road?
Mary Myers North Carolina State Univ.

Proceedings of The ARCC Spring Research Meeting
Architectural Research Centers Consortium

Co-Sponsored by:

The College of Architecture and Urban Studies

at Virginia Tech

The Initiative for Architectural Research

Blacksburg, Virginia, April 2001

The Architectural Research Centers Consortium, Inc. (ARCC) is an international consortium of architectural research centers committed to the expansion of research culture and infrastructure in architecture and related design disciplines. Since its founding as a non-profit corporation in 1976, ARCC has exerted a concerted commitment to the improvement of the physical environment and the quality of life.

The Website for the Architectural Research Centers Consortium can be found at http://www.polaris.net/~arcc/web/

The e-journal for the Architectural Research Centers Consortium can be found at: http://www.asu.edu/caed/arcc/

Proceedings of The ARCC Spring Research Meeting
Architectural Research Centers Consortium

Co-Sponsored by:

The College of Architecture and Urban Studies

at Virginia Tech

The Initiative for Architectural Research

Blacksburg, Virginia, April 2001

All Conference Sessions were held in The Donaldson Brown Hotel & Conference Center on the Virginia Tech campus in Blacksburg, Virginia

Opening address:
Dr. Paul Knox, University Distinguished Professor and Dean of the College of Architecture and Urban Studies, Virginia Tech.

Welcome to this year's ARCC Spring Meeting. It's both a privilege and a pleasure to have you here, and I hope that you will have an enjoyable few days on campus.

Your arrival is timely: those of us from Virginia Tech will be listening carefully to every word, since our President has recently announced ambitious new goals in terms of research productivity for the whole university.

In a recent address to the faculty at the University of Michigan, James Polshek made the point that architects and planners are perceived by the public as weak and culpable figures, blamed for their participation in dehumanizing the environment, for attenuating sense of place rather than enhancing it, and for being pre-occupied with aesthetic innovation and style.

His host, Doug Kelbaugh, followed up by observing that "While every other discipline on campus strives to be good, architecture strives to be new, inventing another architectural style, even another architectural language, every generation."

Polshek blamed everyone and everything, apart from practicing architects themselves: society (especially the acquisitive and materialistic middle classes), clients, business practices, regulations, special interest groups, specialists, commentators, and the AIA, as well as the schools.

It's not a happy state of affairs, however one views it—from the public's point of view, from the profession, or from the schools. Most people would agree that one of our responsibilities in the schools is to act as pathfinders, through basic and applied research, to ways in which the design professions can demonstrate more effectively the beneficent aspects of the art and science of building.

Given this responsibility, there could not be a better time for the schools to ramp up their research activities.

Every few decades a group of technologies comes along and disrupts the old order. I'm very interested in this, because as a geographer I see that what happens is that each new technology system undermines the established order of things and creates a new geography, with new winners and new losers in terms of economic growth and development. But each new technology system also presents unprecedented new opportunities for research and practice in almost every field.

1790-1840: early mechanization based on water-power and steam engines, the development of cotton textiles and ironworking, and the development of river transport systems, canals, and turnpike roads.

1840-1890: the exploitation of coal-powered steam engines, steel products, railroads, world shipping, and machine tools.

1890-1950: the exploitation of the internal combustion engine, oil and plastics, electrical and heavy engineering, aircraft, radio and telecommunications.

1950-1990: the exploitation of nuclear power, aerospace industries, and electronics and petrochemicals; and the development of limited-access highways and global air routes.

1990—: the exploitation of solar energy, robotics, microelectronics, biotechnology, advanced materials, and information technology.

New information technologies have helped create a frenetic international financial system, while transnational corporations are now able to transfer their production activities from one region of the world to another in response to changing market conditions. Architecture and engineering, like law, accounting, advertising and other professions, have become global in scope, and are in the process of being organized around radically new business practices. Products, markets, and organizations are both spread and linked across the globe. Governments, in their attempts to adjust to this new situation, have sought new ways of dealing with the consequences of globalization, including new international political and economic alliances. Amid all this, design has acquired unprecedented importance: smart design, sustainable design, and design as a marker of social and cultural space in the flexible geometry of networked societies.

It has been tempting for some pundits to pronounce the end of history, the end of geography, and the homogenization of culture as a result of the latest technology system. Information technology and the global marketing of standardized products may seem at first glance as if they might soon wash away the distinctiveness of people and places. But far from it. The new mobility of money, labor, products, and ideas actually increases the significance of place in some very real and important ways.

- The more universal the diffusion of material culture and lifestyles, the more valuable regional and ethnic identities become.
- The faster the information highway takes people into cyberspace, the more they feel the need for a subjective setting—a specific region or community—that they can call their own.
- The greater the reach of transnational corporations, the more easily they are able to respond to place-to-place variations in labor markets and consumer markets, and the more often and more radically that economic geography has to be reorganized.
- The greater the success of transnational corporations and the more pervasive global consumer products and global culture become, the more likely it is that they will be actively resisted.
- The greater the integration of transnational governments and institutions, the more sensitive people have become to localized cleavages of race, ethnicity, and religion.

In other words, this latest round of disruptive technologies is not prompting the end of geography but, like its predecessors, creating new geographies. My point here is that, through a parallel logic, the same new technology system also offers the possibility of re-casting both our disciplines and the associated professions.

We can already foresee some of the possibilities: people are already talking about "socially distributed knowledge systems"—clusters of teams and individuals that are both assembled and funded in an ad hoc way. Universities, according to this perspective, will evolve into trimmed-down cores surrounded by a cloud of relationships.

At almost all good research universities, faculty are already tunneling out under the old disciplinary and institutional walls to form these relationships. We need to open the gates and let them build highways. We need to cultivate strategic alliances. It will be difficult to define the core and to manage the relations with the cloud of ad hoc arrangements; but it will likely turn out to revitalize university research rather than damage it.

Currently, about 80 percent of all basic research and about 17 percent of all R&D work in the United States is undertaken by faculty in universities.

Over the past 20 years, industry funding for academic research has expanded at an annual rate of >8 percent.

I don't have the data, but I suspect that in the architecture, urban design, and Landscape Architecture the figures are much lower—government, business, and non-profit organizations rely much more on the research undertaken by engineering and other disciplines than by faculty in our schools.

Worse still, they don't allocate very much at all for research in our fields. Yet designing, planning and constructing the built environment accounts for more than 8 percent of Virginia's economy—more than agriculture, more than health, and more than the military.

It's up to us, of course, to persuade government and industry that they need to fund our research.

That's the first step. But as we then ratchet up our research efforts, there are some important issues that we shall have to confront.

In relation to research training:

- What are the keystones of research competency in the design professions?
- How can we attract more of the top students into research tracks in the design disciplines?
- How can we incorporate design more effectively into research programs? (architecture, of course, tends toward the intuitive and poetic, which often sets it at odds with the scientific method).

There are, though, some much broader questions that we shall soon have to confront. Much of higher education has come to operate on a sort of instrumental individualism. Many academic fields have come to accent the marketability of their technical skills while de-emphasizing their contribution to civic life. There has been a great deal written over the past few years about The University Inc.: universities as knowledge factories; and the consequent undermining of universities' independence.

One important question, therefore, is: Can we use and channel our research in the design professions to help reinterpret the sense of public purpose for our time and to initiate a recovery of the university's identity in the mind of the public?

These are all questions for the near future. Meanwhile, it is clear that research is already of fundamental importance to our health and well-being as academic institutions. Research propagates an atmosphere of innovation and risk-taking, and the results of research generate new knowledge that sustains the development of our academic disciplines. Basic research also provides the foundation for outreach programs and the catalyst for learning environments that are enriched and enlivened by faculty who are engaged in cutting-edge intellectual inquiry.

The greater the reputation of our schools in terms of research output, the more competitive we can be in attracting the best faculty and, in turn, the best students. A benign, cumulative, spiral results: having the best possible faculty and students not only enhances our reputation but also results in more sponsored research; which in turn helps to fund equipment and infrastructure; . . . which attracts the best faculty and students; . . . and so on.

Well, I think that now I am preaching to the choir, and it is time for me to introduce the opening speaker of this year's conference.

Professor Volker Hartkopf is Director of the Center for Building Performance and Diagnostics at Carnegie Mellon University, where he established the first multi-disciplinary program in Architecture, Engineering, and Planning in the United States, with grants from the NSF and the building industry. He now directs a consortium of leading building industries and six U.S. government agencies. . . .

Frank Weiner, Department Head, Department of Architecture, College of Architecture and Urban Studies, Virginia Tech.

Introduction for Dr. Deborah Mayo
ARRC Spring Reseach Meeting/ VT
April 8-10, 2001

My name is Frank Weiner and I am Head of the Department of Architecture at VT. I want to echo Dean Knox's comments yesterday and welcome you all to Blacksburg. I would like to thank in particular Prof. Michael O'Brien for caring for the many logistics of this meeting as well as all the partners from ARCC and I AR that made this meeting possible.

I have never been sure if architecture is knowledge. And strictly speaking it is only knowledge that can be taught and learned. Caught between a practice and a craft architecture sits somewhat uncomfortably in the distinguished company of philosophy and science. To teach architecture is quite another thing. Here knowledge of philosophy is absolutely essential. As architects naturally tend to gravitate towards metaphysics and aesthetics we might be well advised to not overlook the books that came before – physics and logic. Here architects are squarely in the territory of the philosophy of science. One also needs to remember that the word ***science*** originally meant knowledge so that even a phrase as prosaic as "building science" would by necessity have an inherent philosophical obligation.

Our special guest this morning is Dr. Deborah Mayo is an award winning philosopher of science who just a few years ago was the recipient of the prestigious Lakatos Prize. She is currently a faculty member in the Department of Philosophy at Virginia Tech. She is perhaps best known for her critically acclaimed book entitled, Error and the Growth of Experimental Knowledge published by the University of Chicago Press in 1996. One of the strengths of her approach is that it combines a nuanced epistemological rigor with a great sympathy for the complexities and uncertainties of the everyday practice of scientific experiment. In one sense she is searching for the smallest or most local and humble fragment rather than a more totalizing theory.

Virginia Tech is a place that is fond of putting knowledge to work but we can often overlook how new knowledge is generated in particular the logical and epistemological foundations upon which we acquire new knowledge through experiment and research. The beauty of Dr. Mayo's idea is that it places real value upon the notions of errors and mistakes and places these at the foundation of knowledge acquisition in the sciences. In her inquiry Dr. Mayo marshals an enormous range of knowledge ranging from the work of C.S. Peirce on the nature of induction to the philosophy of statistics and a detailed understanding of the primary figures in the philosophy of science.

For the ancient Greeks the idea of doxa or opinion was central to the notion of philosophical knowledge. There was no knowledge or episteme outside of doxa. In a sense one came to knowledge through the "lense" of opinions about appearances. In my view Dr. Mayo has reclaimed the Greek notion of doxa and brought this concept into the realm of scientific discovery. She has achieved this by placing an emphasis on the role of error on the road to the growth of knowledge.

Please join me in welcoming Dr. Deborah Mayo.

Can a Machine Be Trained to Reliably Report the Operational Status of Building Equipment Systems through Simply Listening? And If It Can, So What?

Authors

Paul Woods, Associate Professor, Department of Construction Science, College of Architecture, Texas A&M University

Hoonsik Seo, Ph D student, Department of Architecture, College of Architecture, Texas A&M University

Ken Parker, Ph D student, Department of Architecture, College of Architecture, Texas A&M University

Zeena Pinto, MS student, Department of Construction Science, College of Architecture, Texas A&M University

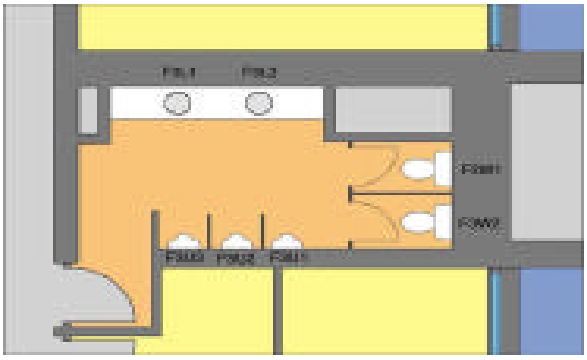
Seongchan Kim, Ph D student, Department of Architecture, College of Architecture, Texas A&M University

Designated Contact Information:

Paul Woods
Box 97
Kurten TX 77862-0097

Voice: 979-589-1151 or 915-426-2233
Fax: (419)844-5361
paulw@tca.net

Airs Experimental Setup



Typical Bathroom Plan

Test Bench

Purpose of the Research

The purpose of this research is to determine the system-wide reliability of the Acoustic Information and Retrieval System (AIRS); and if the reliability is good, describe the potential importance of this new data-acquisition system to architectural research.

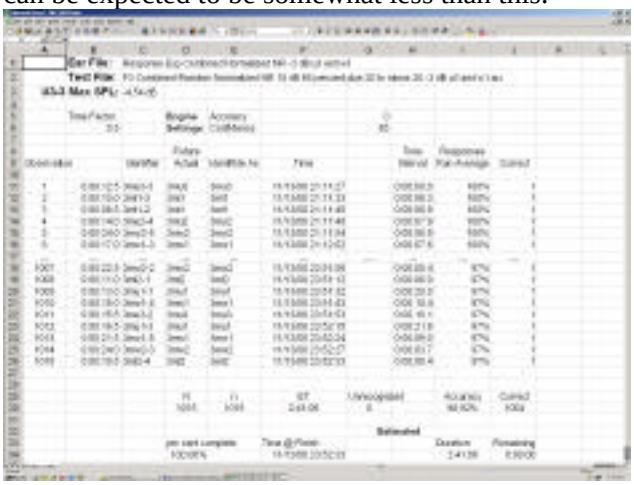
Methods and Procedures

- Digitally record representative acoustic events.
- Prepare a training score for AIRS based on the digital recordings. For the purposes of this research, the term ***score*** means something akin to a musical score: a digital recording of a series of acoustic events.
- Train AIRS.
- Prepare a test score of randomized acoustic events.
- Input the test recording to the AIRS acoustic pattern recognition engine.
- After approximately 1000 replications, calculate the recognition rate.

Score on Cool Edit 2000

Main Results

The experiment resulted in 1004 correctly recognized events and 11 incorrectly recognized events. This is a system-wide reliability near 99 percent under laboratory conditions. Field results can be expected to be somewhat less than this.



Partial Experimental Data Log Spreadsheet

Status of the Effort

Implications for Architectural Research

In this experiment we chose to use the sound generated by plumbing fixtures as they were operated to exemplify an observable acoustic event. Even the ability to successfully observe these seemingly mundane phenomena has important implications to architectural research.

A review of the literature reveals that there is little or no empirical research on the actual use of bathrooms in the US. This is understandable given our socio-cultural bias toward extreme privacy when it comes to bathrooms. Can you imagine trying to get human-subject-committee approval for placing a video camera in a public bathroom or even standing around with a clipboard to make observational notes? I sincerely doubt it. So, this bias mitigates against actually observing how bathrooms are used; and without the ability to make observations, there can be no empirical research. The key to acoustic observations of actual fixture operation is that it maintains personal anonymity while providing meaningful data on actual fixture use.

These data can be used to answer many architectural research questions. Here are four examples for a start:

- What is the proper fixture-to-occupant ratio for different occupancy types?
- What is the proper fixture-to-occupant ratio for different occupancy types based on sex?
- Are certain fixtures of the same type used at a higher frequency in a given bathroom layout than others? If they are, what are the design implications of these asymmetric patterns of use?
- What is the average time per use for different fixtures considering the sex of the user?

Future Work

We have begun live data collection on a seven-fixture men's room in a campus building. We expect to expand our coverage to three more men's rooms and then four additional women's rooms. Once the instrumentation is working reliably, we will begin data collection aimed at answering some of the research questions posed earlier in this paper.

HOW E-COMMERCE IS CHANGINGTHE FACILITY MANAGEMENT PRACTICES OF BUILDING OWNERS

Robert E. Johnson, Mark J. Clayton, Jeong-Han Woo, Ge Xia
CRS Center, Texas A&M University

"The corporate Ford of 2010 will look more like Cisco, a company that manufactures very little."

"Direct-to-the-assembly-line ordering will enable Ford to custom configure cars much the way that Dell custom configures computers."

--Forbes, July 17, 2000

The above quotation is an indication of how information technology is changing even old-line manufacturing organizations. The research reported in this paper was motivated by our desire to better understand how information technology and, in particular, the recent phenomenon of e-commerce, was influencing the design and construction industry. Since trends in the building industry are often determined by the desires and programs initiated by large building owners, we decided to focus our research on facility management organizations in Fortune-500 companies.

Previous Research

The Internet and the application of information technology have grown considerably in the past several years. Electronic commerce has evolved with unanticipated high growth rates and an increased focus on the potential of business-to-business e-commerce. The U.S. Department of commerce has estimated 1) that high-tech has driven more than a quarter of all economic growth since 1993 and 2) information technology sectors are growing at double the rate of the overall economy (David Henry et. al., June 1999). Predictions for growth in the business-to-business e-commerce have been tempered somewhat from enthusiasm of early 2000, but still are predicted substantial double-digit percent increases in growth for 2001. Others have reported that each year, inefficiencies, mistakes and delays account for $200 billion of the $650 billion spent on construction in the United States (Economist, 15 Jan 2000). Clearly this represents an opportunity to improve industry practices. Analysts have identified the AEC market as one ripe for information technology innovation. By one count, venture capital firms have invested $2.5 billion in 217 dot-com start-ups whose goal is to improve the effectiveness and efficiency of outmoded practices in the design and construction industry (Fisher, 2000).

Despite the recent growth of e-commerce, few research studies have begun to clarify the effect of this phenomena. Although there has not been much research conducted on e-commerce and facility management, there are several relevant studies related to strategy and information technology, need for coordination and information technology, and the role of information technology and the Internet on work process improvement.

Block and Segev (1996) studied strategy and IT by analyzing the impact of electronic commerce on the travel industry. This research defined electronic commerce as the buying and selling of information, products and services via Internet and the support for all kinds of business transaction over a digital infrastructure. It defined three layers of technology impact on companies 1) at their boundaries, 2) in their relation with partners, suppliers, and targeted customers, and 3) in their access to market. The study adapted Michael Porter's framework of competitive advantage and proposed a framework to analyze the effects of electronic commerce on the travel industry. The advantage of this approach is that it recognized that the introduction of electronic commerce is likely to impact an industry on several different levels of an organization. In an earlier paper, Porter and Millar (July-Aug 1985) outlined how information technology has an impact on competitive advantage.

Another study (Sanjeev Dewan et. al., September 1998) theorized that organizations that require more control and/or coordination are also likely to have a higher demand for the benefits that information technology may provide. They went on to suggest several hypotheses, including that the higher a company's level of diversification the greater the demand for IT investment, and the higher the level of vertical integration the lower the demand for IT investment. They tested these hypotheses by using data provided by annual surveys conducted by *Computerworld* between 1988-1992. Their results suggested that the level of IT investment is positively related to the degree of firm diversification, perhaps reflecting the greater need for coordination of assets within diversified firms.

Work group productivity and process improvement are two other areas that are heavily influenced by information technology. Ness and Teicholz (May 2000) reported on the increased importance of the World Wide Web on capital planning and management solutions. They noted that "the web-based CPMS [capital planning management systems] will be linked to e-business making it possible for a facility manager to see where the problem is, create the project to repair the problem, and order any materials necessary all from the comfort of his or her office."

Framework

The conceptual framework adopted by this research was an outgrowth of our review of prior research (above) as well as our earlier study that explored the role of information technology in facility management. In this study, business-to-business e-commerce was defined as conducting business communications and transactions among companies over the Internet. The basic premise in our earlier 1996 survey was that organizations adopt information technology in order to help achieve business goals. We used a similar premise in this survey: organizations that adopt e-commerce will achieve improved performance (see Figure 1). This model represents the prevailing "conventional wisdom" in the industry. While there may be other factors that influence performance (e.g., leadership or marketing), our focus was on issues associated with the use of e-commerce. Based on previous research, we also hypothesized that those organizations that systematically improve work processes would have greater success incorporating e-commerce solutions. Other factors that might influence results were hypothesized to be issues associated with organizational context and characteristics of individual respondents.

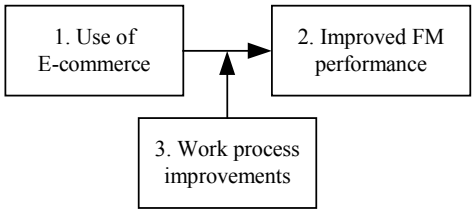


Figure 1. Research Model

Goals and Hypotheses

The purpose of this survey was to develop a rigorous and factual description of how e-commerce and web-based technologies were being utilized by large building owners (facility management

organizations in Fortune 500 companies). Through this understanding it would be possible to speculate about the future growth of e-commerce throughout the industry. An additional goal of the study was to learn how and under what circumstances e-commerce achieves success or failure in facility management organizations. Such an understanding could provide guidance to organizations that are considering venturing into e-commerce applications. Two hypotheses that we planned to test included:

H1: The use of e-commerce will result in improved facility management performance.

H2: Organizations that use systematic work process improvements will tend to be "early adopters" of e-commerce.

Methodology

The method selected for this research was a self-administered survey. Questionnaires were mailed in July 2000 to 1,714 facility managers from Fortune 500 companies who were also members of the International Facility Management Association (IFMA). The sample was designed to reach respondents who tended to manage large, complex facilities and who were considered professional facility managers by virtue of their membership in IFMA.

The questionnaire was designed to cover each of the five major categories described in our conceptual framework, including: the use of e-commerce in facility management organizations, level of satisfaction with current facility operations, barriers to the use of e-commerce, use of systematic work process approaches, and background information about the individual responding to the questionnaire and his/her organization.

As of October 6, 2000, 578 usable questionnaires were returned, for a response rate of 33.7%. A wide variety of IFMA industry groups responded, with the largest response from Vehicle Manufacturers (13%) followed by Telecommunications Service Providers (12%) and Investment Service Providers (11%).

Analysis: Current and Future Applications

Our survey results found that e-commerce is just beginning to emerge as a tool that is used to help manage facilities. The most frequent application of e-commerce today is to purchase supplies and materials on the web from a specific vendor. Almost 2 out of 10 respondents indicated that their department purchases supplies and materials on the web "a lot" (See Table 1). In addition to purchasing supplies and materials, the other top uses of e-commerce were accessing facilities manuals, publishing static project information on the Internet, purchasing supplies and materials through an Internet service that connects buyers and sellers, and taking interactive courses via the Internet.

Respondents have clear expectations that e-commerce in facility management will grow substantially over the next two years and that it will significantly affect facility management practices. Respondents anticipated that e-commerce use will substantially expand in every application category over the next two years, with percent increases ranging from 227% to 900% (Table 1). In addition, almost 1/4 said that they expected business-to-business e-commerce to change their facility management department "a lot" over the same time period. Only 2% said that they did not expect their department to change at all because of e-commerce.

Anaysis: The Impact of E-commerce on Performance

One of our hypotheses was that e-commerce is being used because organizations decided that it would improve their ability to manage facilities. However, our findings suggest that this may not be the case. Respondents felt that e-commerce has not resulted in a major improvement in their ability to more effectively manage cost or time issues. The "payoff" for investing in e-commerce has not yet been clearly demonstrated. Some agree or strongly agree that e-commerce has helped decrease the time to complete projects (55%) or that e-commerce has decreased the cost of purchasing supplies and materials (67%) (see Figure 2). However, a majority disagree or strongly disagree that e-commerce has decreased the cost of facility maintenance and operations (51%), decreased the total annual cost of

facilities (53%), decreased the cost of new construction projects (71%), or decreased the cost of space management (70%). It should be emphasized, however, that these opinions changed substantially when the next two years are considered, with a majority agreeing or strongly agreeing that e-commerce will help decrease both time and cost for all categories. As table 1 indicates, very significant increases in e-commerce use are projected.

Table 1. Respondents reporting use of e-commerce applications "a lot"

	NOW		in 2 YEARS		
E-COMMERCE APPLICATION	**PCT**	**N**	**PCT**	**N**	**PCT Incr**
Purchasing supplies and materials on the web from a specific vendor	18.0%	505	40.8%	553	227%
Accessing facilities manuals (e.g., maintenance or training) using the Internet	9.6%	505	35.4%	544	369%
Publishing static project information on the Internet	7.6%	478	19.4%	517	255%
Purchasing supplies and materials through an Internet service that connects buyers and	5.0%	488	19.4%	527	388%
Taking interactive training courses via the Internet	5.0%	492	27.4%	539	548%
Purchasing furniture on the Internet	3.0%	482	14.3%	521	477%
Managing projects using commercial, third party web sites	2.2%	488	11.1%	508	505%
Purchasing facilities services on the Internet	1.5%	484	9.4%	511	627%
Purchasing energy via the Internet	0.8%	447	6.5%	452	813%
Leasing commercial floor space via the	0.3%	460	2.7%	487	900%

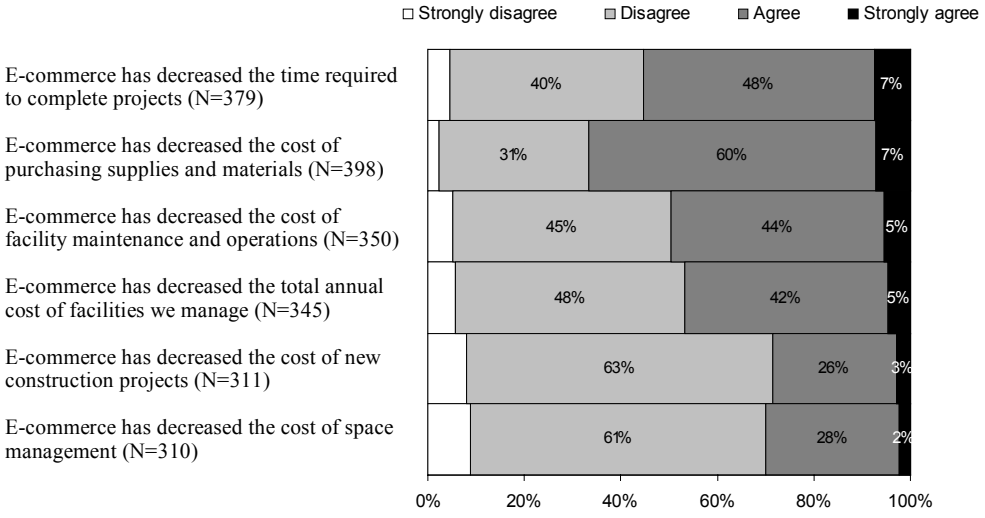


Figure 2. The Impact of E-Commerce on Facility Performance

Analysis: Work Process Improvements and E-Commerce

One of the hypotheses of this research was that those organizations that have implemented systematic work process improvement process will also tend to utilize e-commerce. We surmised this might be the case because e-commerce could be viewed as another method for improving work processes. We asked respondents about whether or not their facility management department utilized a number of management practices that are normally associated with process improvement. Responses showed that many facility management departments used one or more of these practices. Over half of the respondents strongly agreed that their company requires them to track total annual facility costs (Table 2). Other preferred management practices included customer satisfaction surveys, formal benchmarking studies, use of the national CAD standards, and ISO 9000 certification.

Table 2: Top-5 management practice used

MANAGEMENT PRACTICE	Agree	Strongly agree
Department is required to track total annual facility costs	41%	53%
Customer satisfaction surveys	48%	36%
Formal benchmarking studies	48%	24%
National CAD layer standard	49%	23%
ISO 9000 certification	38%	16%

Next, we conducted a bivariate analysis of the use of e-commerce and the use of work processes. The results are presented in Table 3. It appears there is some evidence to suggest that the use of certain work process are significantly associated with the use of e-commerce. Some of these associations are not unexpected. For example, it seems reasonable that those departments that closely collaborate with the company's management information systems department would tend to use e-commerce. Of somewhat more interest is the association between use of e-commerce and use of ISO 9000, use of continuous improvement processes, use of continual retraining of employees, and use of modeling work processes using charts. Further research would need to be done to learn if systematic management practices are good predictors of the effective adoption of e-commerce. Companies who adopt systematic work process analysis may also be good sources of information on "best practice" studies. Further, other organizations in the AEC community may find it useful to consider adopting some of these management practices.

Table 3: Association between use of e-commerce and systematic management practices

MANAGEMENT PRACTICE USED	SIGNIF
Department is required to track total annual facility costs	n.s.
Customer satisfaction surveys	n.s.
Formal benchmarking studies	n.s.
National CAD layer standard	n.s.
ISO 9000 certification	p <. 05
FM dept closely collaborates with MIS dept	p < .05
Use of continuous improvement process (e.g., total quality management)	p < .05
Use of workflow automation	n.s.
Employees are continually retrained	p < .01
Work processes are modeled using charts	p <. 001

Analysis: Barriers to the Use of E-commerce

Overall, 11% felt that implementing e-commerce was a big problem and one-half said that implementing e-commerce was somewhat of a problem. About 12% felt that implementing business-to-business e-commerce solutions was not a problem. The biggest specific problem in implementing e-commerce was reported to be the difficulty in integrating with legacy systems (Table 4). Other top problems included lack of a budget to invest in e-commerce, hard to customize software packages, cost of software upgrades, and cost of keeping building data current.

Table 4: Top-5 barriers to the use of e-commerce

BARRIER	A big problem	Somewhat of a problem
Hard to integrate legacy systems with e-commerce	25%	33%
The necessary budget to invest in e-commerce is not available	18%	24%
Too hard to customize software packages to meet your needs	16%	34%
Software upgrades are too costly	14%	31%
Hard to evaluate e-commerce using return on investment (ROI)	12%	42%

Conclusions

The findings of this survey indicated that e-commerce was just beginning to emerge as a tool that is used to help manage facilities. Respondents had clear expectations that e-commerce in facility management will grow substantially over the next two years and that it will significantly affect facility management practices. The study also found evidence to suggest that those organizations that had adopted systematic methods to improve work processes were more likely to be early adopters of e-commerce. Future research might use focus groups and best practice studies to better identify which management practices are helpful to achieving successful e-commerce implementations.

This study portrays attitudes among facility managers towards e-commerce. The data is suggestive of interesting trends and partially supports our hypotheses, but is not conclusive. This may be due to the immaturity of the use of e-commerce in facility management. As the use of e-commerce expands, future studies may be able to more accurately understand the factors that as associated with its successful implementation and use.

Acknowledgements

The authors of this study would like to acknowledge the financial support of the IFMA Foundation Corporate Circle of Contributors that made this research possible.

References

----. 15 January 2000. “Construction and the Internet.” *The Economist*.

Bloch, Michael and Arie Segev. 1996. *The Impact of Electronic Commerce on the Travel Industry: An Analysis Methodology and Case Study*. Fisher Center for Information Technology and Management, U.C. Berkeley.

Dewan, Sanjeev, S. Michael and C. Min. September 1998. *Firm Characteristics and Investments in Information Technology: Scale and Scope Effects*. Information Systems Research, Vol 9, No 3, p 219-232.

Fisher, Susan E. May 12, 2000. “Can Construction Adapt to Online Markets?” InfoWorld.com.

Haltiwanger, J. and R. S. Jarmin. July 1999. *Measuring the Digital Economy*.

Henry, David, et. al. June 1999. *The Emerging Digital Economy II*. U. S. Department of Commerce, Secretariat on Electronic Commerce: Washington, D.C.

Johnson, Robert and Mark Clayton. 1998. “The Impact of Information Technology in Design and Construction: The Owner’s Perspective.” *Automation in Construction* Vol 8, p. 3-14.

Johnson, Robert and Mark Clayton. October 17, 2000. *The Impact of E-Commerce on Facility Management Practices: A Survey of Fortune 500 Facility Management Organizations*.” IFMA Foundation Research Report.

Ness, Richard and E. Teicholz. May 2000. “Web Technology: The Impact on Facility Management is Just Beginning.” *World WorkPlace 2000*, IFMA, Sep 17-19, 200, New Orleans.

Porter, M. and V. Millar. Jul-Aug 1985. “How Information Gives You Competitive Advantage.” *Harvard Business Review*, pp. 149-160.

New Approach for Documenting Historic Buildings

Hussein F. Abaza, Ph.D. student, College of Architecture, Virginia Tech University, Blacksburg, Virginia

Yvan Beliveau, Professor, Department of Building Construction, Virginia Tech University, Blacksburg, Virginia.

Abstract:

This paper discusses utilizing new 3D CAD system for documenting historical buildings. The 3D CAD modeling was used to generate three-dimensional drawings of the Main Justice Building Court yard. The courtyard, which covers approximately 4,500 square meters is situated over top of a parking garage in the Main Justice Building in Washington DC, and is comprised mainly of stonework.

The scopes of the renovation work includes salvaging the courtyard stone, demolishing and rebuilding the concrete structure of the car parking below the courtyard, and reinstall the salvaged stone back in its original location. Traditionally, the measuring tape is used to document the vertical planes, and conventional surveying equipments are used to document the horizontal planes. In this project, the courtyard stone pieces are inherited in the building structure and some of the stones have unique three-dimensional configurations that cannot be surveyed by conventional techniques.

ValcunÆ 3D CAD modeling was used to document the locations and the shapes of the stonework in the courtyard before removing the stone and demolishing the concrete structure. 3D CAD modeling has the ability to locate the required points in the three- dimensional space. 3D CAD modeling was used to generate 2D and 3D CAD drawings for the courtyard. These drawings were used to re-fabricate the dismantled stones, and to reinstall the salvaged stones in their original locations.

The field surveying of the courtyard was completed in 16 working hours. More than 3000 stone pieces were located in the three dimensional space to an accuracy range of 1/8" (Arch Second, 2000).

Key words: 3D-I Technology, Renovation, Surveying, Historic Buildings.

3D-I Technology:

The term three dimensional, or 3D, means that all objects can be described in terms of physical dimensions including location, size, and shape. Many engineering practices require locating and positioning objects in space; however,

accurately determining a 3D location in space is very difficult. 3D-I technology uses laser beams and hand-held devices to instantly deliver and store data to Pocket PC for the creation of digital 3-D models of large objects or environments for design (Beliveau, 1996).

Similar in concept to surveying technology already used for mapping project sites and taking as-built readings, 3D-I uses precisely timed signals from two or more laser transmitters to establish the precise location of a handheld receiver. Unlike other instruments, the users don't need to level the instrument, and the 3D-I system updates the receiver position five times a second(Beliveau, 1996).

The 3D-I system is made up of two laser transmitters and a measurement tool. The two laser transmitters create a 3D measurement volume “a 3D-Intelligent environment” (Arch Second, 2000). The versatile measurement tool measures 3D points anywhere within this environment. This system provides a one person operation, indoor and outdoor operation, daytime and nighttime use, quick set up, and full CAD integration (figure 1).

Figure 1: VULCAN 3D-I system.

3D-I software can convert raw data into useful formats for specific applications. The 3D-I data collector is Windows CE based application. Data can be entered through a touch screen user interface. Users can collect, store, edit and view 3D measurements in real time including coordinates, distances, angles, areas, and volumes. This 3D-I surveying tool also allows for easy data transfer to and from a personal computer for use in CAD and Windows® based programs.

The 3D-I technology was chosen to document and create the as-built drawings for the stonework at the Main Justice Building courtyard for the following reasons:

A- Traditionally, the measuring tape is used to document the strait dimensions and the vertical planes, and conventional surveying tools are used to document the horizontal planes, angles, overall dimensions, levels, and radial dimensions. In order to take accurate measurements, these surveying tools require that the surveying stack to stay perpendicular to the measured surface. In the Main Justice Building case, many stone configurations in the courtyard have unique three-dimensional configurations, where taking field measurement while keeping the surveying stack vertical is impossible.

B- Conventional surveying tools require a clear eye of sight between the surveying machine and the surveying stack. Some of the stone pieces in the Main Justice Building courtyard have complex three-dimensional shapes, and the stone edges do not always have clear eye of sight to the surveying tools. The convention surveying tool cannot measure these stone pieces. However, the 3D-I system measuring bar can access these points.

C- The Main Justice Building courtyard contains more than 3000 stone pieces. In order to accurately document the locations of all stone pieces, four readings have to be taken for each stone piece. In conventional surveying techniques, these readings are taken by using both measuring tape and surveying tools.

In surveying the Main Justice Building courtyard, it was overcomplicated to co-ordinate this amount of electronic data from the surveying tools with the manual tape measurements. In the 3D-I system, manual tape measuring is not required.

Further more, in the tape measurements, each stone piece is measured separately, and any measurement discrepancy cannot be traced easily, while in the 3D-I technology, all readings are related to the same reference points, where the measurement discrepancy does not exist, and any human error can easily be traced(Frank,2000).

D- In the conventional surveying technology, at least two persons are needed to carry out the surveying task. At least one of them should be a surveying technician. In this particular project, documenting the stone requires architect participation in the field surveying in order to make the required sketches in the field, and to generate the final as built drawings. Most architects do not have the experience to run sophisticated surveying systems. However. The 3D-I technology produces Auto-CAD files, which are familiar to architects . The architect can also start generating the as-built drawing in the filed. In the 3D-I tool, the architect can assign layers, blocks, and files to the deferent building elements, and he/she can use them later to generate as built drawings.

Generating 2D Drawings.

The 3D-I system produces three dimensional space representation of the building. However, the required as-built drawings in this project are two-dimensional drawings.3D-I system also exhibit the measured dimensions in a form of three dimensional points, The users then have to connect these points to create the required drawings.

Further more, Auto-CAD treats the drafting and dimensioning in two-dimensional space and in three-dimensional space differently, thus the "plan view", and "elevations views" in the three-dimensional space drawings will not supplement the required two-dimensional as-built drawings. In order to produce a two dimensional drawings out of the 3D-I three dimensional points representation, the following procedures were used:

First, Each 3D-I CAD file that is generated through field surveying was used to produce two sided elevations and a plan in 2D space. If more than one plan view is required, the building surfaces at different levels were assigned different "layers" while taking the measurement by the 3D-I system. Each of these layers then was treated separately as a new drawing.

Second, a Visual Basic macro was written through Auto-CAD 2000 to convert the point properties of the drawings which are produced by the 3D-I system. This Visual Basic macro can change the values of all Z coordinates of the collected points in the plan file to zero, all X coordinates values for all collected points of side elevation file to zero, and all Y coordinates values for all collected points of the side elevation file to zero.

Third, the collected points by field surveying are now represented in two-dimensional space. These points were connected by "line" command in Auto CAD to generate the two dimensional drawings. The dimensioning for these drawings was also created in a two-dimensional space.

Project Description:

The Main Justice Building is the United States Department of Justices headquarters, which is located in the Washington DC downtown. It was built in 1933. As with most new classical style building, the Main Justice Building facades are composed of highly decorated stonework.

The main offices in the building are surrounding a central courtyard, which tops a car garage. The scope of renovating the Main Justice Building includes salvaging the courtyard stone, which has historical value, demolish the concrete structure of the courtyard, apply new water proofing for the new concrete slab, and then reinstall the salvaged stones in their exact locations.

Since some of the stone pieces are dismantled, these stone pieces must be replaced with new stones.

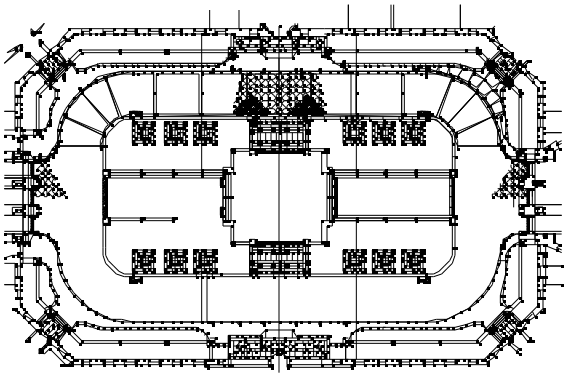


Figure 2: Plan of the Main Justice Building Courtyard.

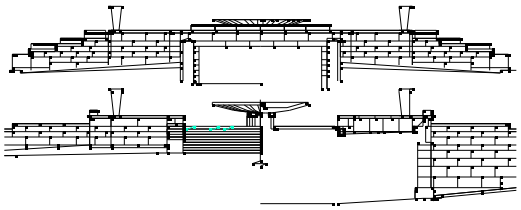


Figure3: Section and elevation of the Main Justice Building Courtyard.

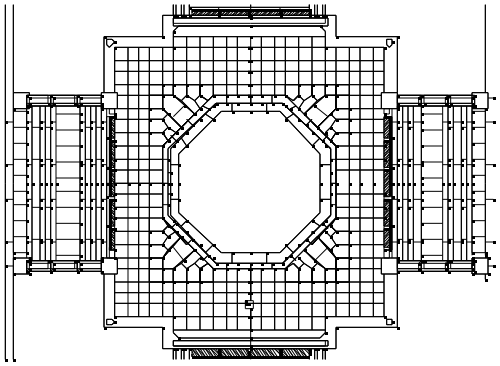


Figure4: Plan of the Main Justice Building Courtyard plaza.

Documenting procedures:

Since 3D-I technology was not used before to document historic buildings, new procedures were developed to accomplish the building documentation task. These procedures were summarized as follows:

First: A damage survey was carried out to document the courtyard stone condition. Each stone piece was inspected to report any damages, photographed, and given a number.

Second: 3D-I surveying system was used to prepare as built drawings for the existing courtyard. The courtyard was divided into 4 quarters; each is approximately 30 x 40 meters. At each quarter, a temporary benchmark was established and related to the benchmarks of the building. Using the 3D-I system, the architect who would eventually produce the as-built drawings did a one-man surveying task. Approximately 2000 readings were recorded for each quarter of the courtyard. Each quarter required approximately 3 hours to set up the system and to take field readings. The total time that was required to accomplish the 3D-I surveying for the entire courtyard was 16 working hours. The training period on how to use the tool, setup the computer software, and to run a demonstration lasted for 1_ hour.

Third: The AutoCAD files, which are generated by the 3D-I cad tool, were processed to generate conventional as built two-dimensional drawing. These drawings incorporated the stone numbers, the dimensions, and the damage survey. (Figure 2(,(Figure 3), (Figure 4).

Conclusion:

This paper examines utilizing the 3D-I technology to document historic buildings for renovation purposes. The results showed that the 3D-I technology proved to be fast, accurate, and more convenient for architects to carry out building documentations. New procedures were used to generate the two-dimensional drawings in order to document this historical building. The time used to carry out the surveying and to produce the as-built drawings in this project was a fraction of what it could take if the conventional surveying systems were used.

References:

Arc Second, 2000): VULCAN 3D-I measuring system, Users Manual of VULCAN 3D-I system. Washington DC, Virginia, www.arc second.com.

Beliveau, Y.(1996), "What can real-time positioning do for construction?", Automation in Construction. v 5 n 2 May 1996. p 79-89.

Beliveau, Y.(1996), " Real time positioning and equipment control for hostile environments", ASCE Specialty Conference, Proceedings 1996. ASCE, New York, NY, USA.. p 64-70.

Beraldin, J (1997), "Short- and medium-range 3D sensing for space applications " Proceedings of SPIE - The International Society for Optical Engineering. v 3074 1997. Society of Photo-Optical Instrumentation Engineers, Bellingham, WA, USA.p 29-46.

Frank Moldstad (2000), "New Pocketcad® Software Functional Computer-aided Design for the Mobile Professional " Talk Media Online.

Langer, D. " Imaging laser scanners for 3-D modeling and surveying applications", Proceedings - IEEE International Conference on Robotics and Automation. v 1 2000. IEEE, Piscataway, NJ, USA. p 116-121.

Create, view, and edit drawings in the field with PocketCAD on architecture Week, Page N1.2 . 28 June 2000

Factors Leading to a Model Predicting the Compressive Strength of Concrete by Means of Its Sound-Transmission Properties

Authors

Paul Woods, Associate Professor, Department of Construction Science, College of Architecture, Texas A&M University

Zeena Pinto, M. S. Student, Department of Construction Science, College of Architecture, Texas A&M University

Emmit Coots, Undergraduate Fellow, Department of Construction Science, College of Architecture, Texas A&M University

Richard Burt, Assistant Professor, Department of Construction Science, College of Architecture, Texas A&M University

Purpose of the Research

The purpose of this research is twofold: 1. Design and fabricate a test stand for use in these laboratory experiments and 2. determine if any of several independent variables have the ability to predict the compressive strength of concrete. The independent variables that we will test all arise from the acoustic signature produced from the impact of a hammer on a standard, concrete test cylinder.

Importance

This research is important for two reasons. First, the equipment required for this type of test is less costly and generally more widely available than the standard hydraulic ram now used for testing concrete samples. Second, if this method works on standard concrete test cylinders, it may be possible to transfer this technology to in-place, impact-echo testing of concrete.

Related Prior Work

In 1948, Ernst Schmidt developed what became known as the *Swiss Hammer* for testing the strength of concrete (Malhotra, 1976). This device works on the principle as explained by Kolek (1958): "When concrete is struck by a hammer, the degree of rebound is an indicator of the hardness of the concrete". The device was tested extensively in Switzerland. These tests established a correlation between compressive strength and rebound number. Other researchers soon found several factors that could effect the relationship between strength and rebound number (Kolek, 1958). This resulted in the observation that tests of this type are only effective

when correlations are made using the identical concrete and forming methods as employed in the structure to be tested.

Another method that gained wide interest is Pulse Velocity measurement. This process basically measures the velocity of a propagated acoustic wave through concrete. Early tests found that while the method was effective at locating faults in concrete, it was not very useful in determining compressive strength (Sturrup et al. 1984).

According to Carino (1994), "The ultimate objective is the development of a technique which is reliable, simple to use and inexpensive. Despite many years of research, there is no method that satisfies all of these criteria. Exploratory research should be designed so that the performance of a prospective test method is evaluated over a wide range of conditions. To avoid drawing faulty conclusions about the suitability of a new method, a statistically-based screening test program should be used to permit valid conclusions to be drawn about the effects of different factors …" Our work is a first step toward such a result.

Methods and Procedures

- Design and fabricate the test stand.
- Prepare seven concrete test cylinders from one batch of concrete.
- Test one of the seven cylinders approximately every four days as they mature over the standard 28-day curing cycle.
- Place each standard concrete cylinder on the test stand.
- Secure an Acoustic Information Retrieval System (AIRS) sensor to the cylinder, generate a controlled, repeatable sound by the impact of a steel object on the concrete cylinder.
- Digitally record the acoustic signal produced by the impact.
- Repeat this test for a total of 5 replications for each cylinder.
- Obtain measured values for the following independent variables: event duration, peak amplitude, minimum RMS power, maximum RMS power, average RMS power and number of peaks.
- Destructively test the cylinders to determine their compressive strength.
- Perform a multiple regression analysis to determine if there is any significant treatment effect on the dependent variable, compressive strength, due to any of the independent variables. Construct a predictive model that will predict the compressive strength based upon a significant set of independent variables.

Main Results

Test Stand

A test stand was designed, fabricated and used to collect data for the study. Although it is heavy and difficult to move, it is excellent for laboratory use.

The sensor consists of a microphone, stethoscope head and connective tubing. These components are all enclosed in a steel electrical box. A spring steel clamp is attached to the box opposite the stethoscope head.

Figure 1. Acoustic Sensor

The test stand is designed to hold a standard six-inch diameter concrete test cylinder. The cylinder is placed into the test stand. Once a steel C clamp is firmly attached to the cylinder, the acoustic sensor is secured to the C clamp.

Figure 2. Test Assembly

The microphone lead is now attached to the acoustic sensor and the microphone input port on the computer. The hammer is set to the desired height and the pin removed. The impact of the hammer on the concrete is recorded digitally using a program called Cool Edit 2000.

Figure 3. Two Typical Impact Waveforms as Displayed on Cool Edit 2000

The Data

All observed values for the independent variables are calculated within Cool Edit 2000. The variables are: Event Duration, Maximum-Minimum Sample Value, Peak Amplitude, Minimum-Maximum RMS Power, Average RMS Power and Total RMS Power.

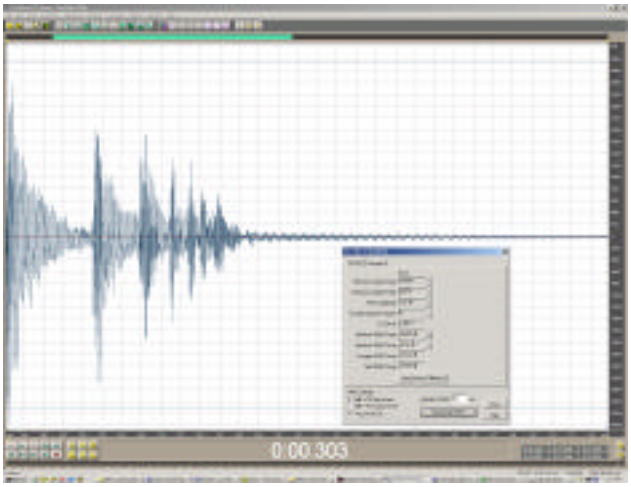


Figure 4. Cool Edit 2000 Observed Waveform Statistics

The dependent variable is Compressive Strength. This observation is measured on a standard hydraulic press designed for this purpose. This measurement is done according to ASTM standards.

Analysis

The statistical analysis resulted in the following:

- Four of the eight independent variables are statistically significant at the .01 level. These are: Minimum RMS Power, Frequency, Minimum Sample and Peak Amplitude. The predictive model constructed from these four variables had an R-Square of .80.
- A satisfactory predictive model was created using the four significant independent variables and a constant. The resulting equation is: Compressive Strength = 16948 + 156.55 Min RMS Power – 3.086 Frequency + 0.1918 Min Sample + 953.3 Peak Amplitude + Error. This model has an overall significance better than 0.0000000035.

Status of the Effort

The results of the current study pave the way for our next experiments. In the next project we will test the compressive strength of five concrete cylinders per day for 30 days. The test will consist of recording five impact events per cylinder and then immediately destructively testing the cylinders on a hydraulic press to measure the compressive strength

of each cylinder. Statistical analyses will then be performed to determine if the compressive strength of the concrete cylinders can be predicted by any subset of the proposed independent variables we measured in this current experiment.

REFERENCES :

Carino, N.J., 1991b, "pullout Test," Chapter 3 in Handbook on Nondestructive Testing of Concrete, V.M. Malhotra and N.J. Carino, Eds., CRC Press, Boca Raton, FL, pp.39-82.

Kolek, J., 1958, "An Aprreciation of Schmidt Rebound Hammer," *Magazine of Concrete Research*, Vol. 10, No. 28, March, pp. 27-36.

Malhotra, V.M., 1976, Testing Hardened Concrete: Nondestructive Methods, American Concrete Institute Monograph No.9, ACI/Iowa State University Press, 204 p.

Sturrup, V.R., Vecchio, F.J., and Caratin, H., 1984, "Pulse Velocity as a Measure of Concrete Compressive Strength," *In Situ/ Nondestructive Testing of Concrete*, V.M. Malhotra, Ed., ACI SP-82, American Concrete Institute, pp. 201-227.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.89598227
R Square	0.802784228
Adjusted R Square	0.776488792
Standard Error	400.5735692
Observations	35

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	19594898.75	4898724.689	30.52941287	3.46307E-10
Residual	30	4813775.531	160459.1844		
Total	34	24408674.29			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	16947.85248	2474.668818	6.848533575	1.33827E-07
Min RMS Power	156.5460891	22.50923837	6.95474838	1.00271E-07
Frequency Hz	-3.085928239	0.94342185	-3.270995091	0.002695164
Min Sample	0.191790199	0.077264556	2.482253294	0.018877371
Peak Amplitude	953.3313111	358.2809696	2.660848306	0.01239603

Table 1

Transportation + Street Trees: Effect of the Urban Design Industry's Roadside Landscape Improvement Standards on Driver and Pedestrian Performance

Jody Rosenblatt Naderi, Assistant Professor, Texas A&M University
Department of Landscape Architecture and Urban Planning
College of Architecture Langford Center
Texas A&M University,
College Station, Texas
Phone: 979-845-1019
Email: jrnaderi@archone.tamu.edu

Byoung-suk Kweon,Ph.D., Assistant professor, Landscape Architecture and Urban Planning and Interim Director, Psychophysiology Laboratory, Texas A&M University

Christopher D. Ellis, Ph.D., Assistant Professor, Landscape Architecture and Urban Planning, Texas A&M University

Enrique Serna, M.L.A. student Texas A&M University

Purpose

The purpose of the research is to examine the effect of industry standard urban design treatments for streetscaping of Main Streets on traffic accident rates and the pedestrian's perception of accessibility and safety. Existing research (Rosenblatt, Bahar) has indicated that the use of roadside landscaping is reducing vehicular traffic accident rates both in terms of frequency and severity. This paper identifies the next research steps being developed at Texas A&M University which will create better understanding of the impact of specific streetscape design treatment on pedestrian safety and accessibility. These standards will be evaluated for the effect on bicycle, pedestrian and wheelchair performance within the treated corridors.

Existing Research and Strategic Needs

Mainstreets projects, pedestrian corridor improvements and scenic highway landscapes are all subject to a set of official design guidelines housed in the American Association of State Highway and Transportation Officials (AASHTO). Members of AASHTO conduct extensive amounts of investigation and research to develop design guidelines that are then employed by all state highway organizations across the United States. Closer examination of the standards being applied in the design of the urban design corridor enhanced our understanding of how we should manipulate the standards to determine thresholds.

Concurrent to identifying and selecting the landscape and urban design standards currently in use in the public rights-of-way, we are also investigating the nature of the multi-modal corridor of the boulevard. We call it multi-modal because it includes, rightly or wrongly, commuters, recreational users, health enthusiasts, skateboarders, tricycles, wheelchairs, children, elderly, shoppers, etc. Understanding the realm that all these users would share is important to understanding the impact of streetscape elements. In fact, it is during this part of the research that the clues to the underpinning challenge emerge.

For example, the AASHTO guidelines look at the overriding necessity to consider pedestrians: "Because of the demands of vehicular traffic in congested urban areas, it is often extremely difficult to make adequate provisions for pedestrians. Yet this must be done, because pedestrians are the lifeblood of our urban areas, especially in the downtown and other retail areas (AASHTO 1995).

While addressing the pedestrian within the road has been the traditional realm of architects, landscape architects, and planners responding to their clients' and local community needs, this has not traditionally been the focus of AASHTO guidelines. As its membership and history reveals, AASHTO has focused on the highway –moving more vehicles through safely in a shorter period of

time. As a result, the pedestrian oriented and roadside landscape standards have been developed in response to the needs of the motorized traffic. It is likely that a different set of standards and guidelines are employed when developing a realm for the range of pedestrian and non-motorized uses of the boulevards. The transportation experience which results, depending on which guidelines you use to govern your design, are summed up poetically by Czech writer, Milan Kundera: "A road is a tribute to space. Every stretch of road has meaning in itself and invites us to stop. A highway is the triumphant devaluation of space, which thanks to it has been reduced to a mere obstacle to human movement and a waste of time. In the world of highways, a beautiful landscape means: an island of beauty connected by a long line with other islands of beauty. In the world of roads and paths, beauty is continuous and constantly changing; it tells us at every step: 'Stop!' (Kundera 1991)."

To evaluate the standards that we will be testing, we conducted a review of the concept of the pedestrian's needs carried in human factors, anthropology, engineering and urban design references. We assigned ourselves the task of constructing a habitat and we seek to understand the behaviour of the animal, its eating and sleeping habits, recreational and health needs and mating patterns. Considering only the spatial needs of the pedestrian as such a genus, the anthropologist Edward Hall called for a perspective on man's spatial needs in the 1960's as follows: "If one looks at human beings in the way that the early slave traders did, conceiving of their space requirements simply in terms of the limits of the body, one pays very little attention to the effects of crowding. If, however, one sees man surrounded by a series of invisible bubbles which have measurable dimensions, architecture can be seen in a new light (Hall 1966)."

And in Hall's work we find clues to how we will be structuring the experiment as it relates to adjusting standards to increase pedestrian safety: "When stress increases, sensitivity to crowding rises – people get more on edge – so that more and more space is required as less and less is available (Hall 1966)."

Urban designer Unterman's classic Accommodating the Pedestrian, presents guidelines for pedestrians based on pedestrians viewing cones as part of their spatial requirements, suggesting that "New fences, retaining walls and buildings should ideally be set back from the sidewalk by 3 to 5 feet to compensate for this lost traveling space. Since people walk to the left or right of persons in front of them, 30 inches wide allows for this offset. For planning purposes, this author recommends a three-foot capacity. This width allows for the offset space of pedestrians and more correctly approximate the amount of space needed to accommodate more than one pedestrian (Untermann 1984)." Together, Unterman's guideline would suggest a width consideration much greater than the basic consideration of the AASHTO guideline.

The AASHTO guidelines present a different view of the minimum dimensions for the pedestrian: "The physical dimensions of the human body are reflected in the design of pedestrian facilities. For the design of sidewalks, stairs, refuge areas, or transitloading areas, knowledge of the width and depth of the body or the effective body area is most useful. Studies have shown that nearly all adult males have a shoulder width less than 525 mm and a depth of less than 330 mm. For design purposes, the area of a body is approximated by an ellipse 600 mm wide and 450 mm deep (AASHTO 1995)." This is a 150% difference between one standard and another.

The importance of existing pedestrian research to our experiments is that the parameters can be tested in controlled environments and guidelines can be examined against each other.

Street trees are another standard used throughout main streets and similar urban design improvements, guidelines for which are similarly contradictory. However, Rosenblatt/Bahar's research in Toronto revealed an unusual correlation between the introduction of landscape improvements and traffic accident rates on 5 case

studies. Their results showed decrease in accident frequency and severity on all mid-block cases during an ambient condition of rising frequencies and severities. In other words, trees appear to be saving lives, so cost-effectively, that in some instances, their research showed the cost of the landscape installation paid for itself in savings from reduced accident rates using WTP.

However, in the National Cooperative highway Research Program Project 17-18(3), AASHTO consultants identified crashes with trees as one of the top 6 emphasis areas for the September 2000 Strategic Highway Plan. According to this document, "Trees are the objects most commonly struck in run-off-road collisions, and tree impacts are generally quite severe. Collisions with trees represent on the major types of traffic fatalities. A complicating factor in addressing fatal tree crashes is the widespread interest and indeed promotion of tree-planting and preservation associated with highways. This area of the strategic plan is one of the few that appears to represent a significant conflict with other priorities of AASHTO and the public, i.e., 'context sensitive design' (NCHRP 2000)."

Whether practitioners are involved in community design projects (Smartgrowth), new urbanism, context sensitive design, Tea 21, Scenic Highway or Main Streets programs, they will be confronted with standards that will govern their approval process. Although the existing power structure of the Highway and Roads Departments is slowly shifting to accommodate the changing demands of the public for quality neighborhoods and streets, quantitative rationale is required to convince engineers, politicians, lawyers, lay-people and accountants who predominate these decision-making processes.

The intention of the research is to provide the profession with quantitative rationale around the application of certain design guidelines to assure maximization of safety and accessibility for multi-modal corridor conditions (bicyclist, wheelchair, pedestrians) subjected to standard urban design treatment. Pedestrian comfort and accessibility is explored considering different types of sidewalk and boulevard conditions including commuting pedestrian, recreational pedestrian, meditation and health-oriented walkers, shoppers. We will begin to explore the nature of standard landscape treatment on behavior of pedestrians and bicyclists sharing the same transportation corridor.

Hypothesis

The first hypothesis is that standard landscape/urban design treatments influence accident rate severity and frequency of automobile drivers. Dependent variables are reaction time and speed, which are traditional indicators of accident rates.

The second hypothesis is that the same standard landscape treatments influence the full scope of sidewalk use. We will measure perception of accessibility for various types of common sidewalk activity. We will also investigate peoples' perception of safety and levels of stress by physiological response (skin conductance, blood pressure, etc.). We will also measure walking speed and comfort levels for all types of users in response to congestion, sidewalk widths, and landscape treatments. Multi-modal use of the sidewalk/boulevard area will be measured including wheelchairs and various types of pedestrians such as the commuting pedestrian, the recreational pedestrian, and the exerciser to determine variations in spatial needs.

Methodology

To assure that streetscape standards which increase safety are used, we will identify landscape factors that enhance driver behavior through the use of the Texas Transportation Institute's (TTI) virtual simulator. Corridors will be created virtually, drive throughs will be performed by subjects, responses to events will be monitored through psychophysiographic measuring devices, eye-tracking, etc.

The simulator at TTI uses "tiles" of images can be combined into various transportation corridor configurations as shown in Figure 1. This facilitates emulation of a variety of design conditions both mid-block and at intersections.

The "post" landscape treatment standards can be applied graphically to the same visual base corridor. Drivers can "drive" through the landscape in a full-size car which is inside the simulator. 3-D images allow the designer to test various configurations to assure that the simulation reflects the standards as shown in Figure 2. Tiles are available to facilitate testing suburban, rural and urban conditions and can be linked together in

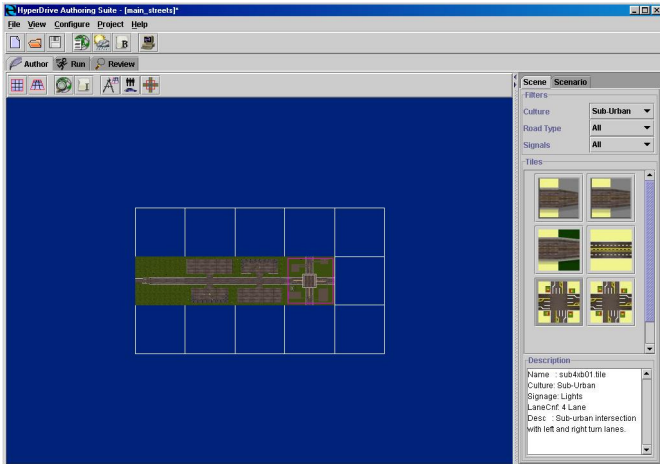


Figure 1. Simulator graphic "tiles" available to create scenarios.

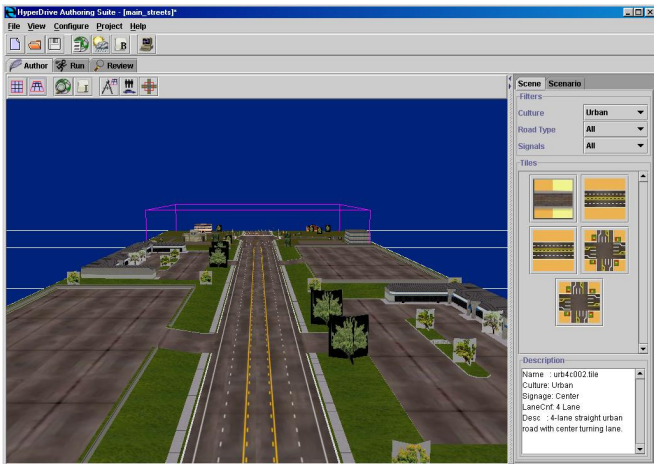


Figure 2. 3-D simulation to facilitate design

any combination to achieve a variety of roadside conditions, which are projected on large screens around the driver in the car. The pc is used to operate the simulation from a remote station.

The subject sits in the car and is asked to drive through a simulated landscape, responding to incidents during the course of his ride and answering a survey at the end of the test. He/she then drives through the same corridor, this time treated with standard landscape treatment, responding to the same or similar incidents and answering a survey at the end of the test. Standard landscape treatments will include street trees, planters/verticals, brick, and hard and soft surface pavement designs. The drive through scenarios are fairly easy to design, like a lego set assembly, and the sensation in the car is that you are actually driving through the landscape.

Determining the effect of the same treatment on pedestrians, wheelchair operators and bicyclists using the same industry standards will be measured through the use of the simulator and through the use of before-after imagery stills that depict standard streetscape treatment associated with Main Streets projects as in Figures 3, 4 and 5. In Figure 3, the standard suburban road includes 2-lane, each way with a central median area painted off. The existing grass boulevard is a boon for the neighborhood, providing some buffer between the travelway of the vehicles and the pedestrian facility. The sidewalk is a standard five foot width, concrete surface, dipping at driveway intersections to accommodate egress of cars.

Figure 4 shows the grass boulevard on the side has been used as a base for boulevard street tree planting. The painted central median has been demolished and a raised grass median has been installed with trees. The image represents the condition at maturity.

In Figure 5, the same road is depicted as in Figure 3, but this time standard includes typical planter box installation on central median with shrubbery. Often, this higher end maintenance solution is appropriate in areas where neighbors will take on maintenance costs, such as in CBD areas.

Using the physiological measuring devices of skin conductance, heart rate and eye tracking devices, the subject's reactions to changes in roadside and boulevard conditions as he/she

operates either a bicycle machine or a treadmill will be evaluated in terms of response to events and quantified to determine the level of safety and accessibility achieved through each of the streetscape standards improvements.

All user groups will be tested. Car drivers will be tested using curbside and median treatment to identify which features provide maximum safety benefit. Boulevard users will be tested using curbside treatment only. Number of people will be distributed amongst commuter pedestrian, recreational, exerciser and wheelchair. In the following example, the control variable will be constant congestion level in all cells. We are testing how do various landscape treatments modify perception of accessibility and safety. The tentative study cells for the experiment at this point shown in Table 1.

Figure 3. Pre landscape treatment condition for Road X. ©

Figure 4. Post landscape treatment condition for typical suburban road shown in Figure 3. ©

Figure 5. Same road as depicted in figure 4 but standard includes typical planter box installation on central median ©

Main Results

There is enough evidence in the literature and in practice to indicate that the use of standard streetscape treatments (roadside landscaping, central median enhancements, street trees) in small communities across the United States and Canada is becoming as pervasive as engineering or architectural standards, especially since the funding opportunities created by Scenic highways legislation and TEA-21 have emerged. Unfortunately, designers do not have enough awareness of the effect of "streetscape" industry standards on driver and pedestrian safety and the application of the standards is lacking guidelines that address these issues. With FHWA releasing its new sidewalk and trail design guidelines, it is important to examine the multi-modal response to sidewalk, streetscape and urban design standards so that trade-offs within the curb lane and boulevard area do not compromise accessibility and safety of all users.

We expect to find that landscape treatment reduces accident rates both in terms of severity and frequency and that some treatments are more effective on driver speed and reaction time than other standard treatments. We expect that safer environments are created as a result of implementing landscape and urban design treatment than would exist if no treatment were implemented.

We also expect results that indicate that application of standard landscape treatments are increasing multi-modal user perception of accessibility and sidewalk activities. We expect

that post-landscape treatment will result in improved walking speeds and comfort levels for all types of users.

Table 1. Study cells for experiment.

# of people	30	30	30	30	30
CSW Width/standard condition	Trees curbside	Planters curbside	Grass curbside	asphalt curbside	Colored brick
1.5 metres					
2.5 metres					
3.0 metres					
3.5 metres					
5.0 metres					
# of drivers	30	30	30	30	30
	Trees curbside	Planters curbside	Grass curbside	asphalt curbside	Colored brick
Median with trees					
Median with planters					
Median with trees and grass					
Median with grass					
Concrete raised median					
No median					

References

American Association of State Highway and Transportation Officials (AASHTO). 1995. A Policy on Geometric Design of Highways and Streets 1994. Washington, D.C.: American Association of State Highway and Transportation Officials.

Fruin, J.J.1971.Pedestrian Planning and Design. Metropolitan Association of Urban Designers and Environmental Planners, Inc.

Fruin, J.J. 1971. Designing for Pedestrians: A Level-of-Service Concept. *HRB,* Vol.308, pp. 1-15.

Hall, E.T. 1966. The Hidden Dimension. Garden City, NY: Doubleday & Company, Inc.

Huchingson, R.D. 1981. New Horizons for Human Factors in Design. New York, NY*:* McGraw-Hill.

Jackson, J.B. 1984. Discovering the Vernacular Landscape. New Haven: Yale University.

James, J.G. 1950. The Perception of the Visual World. Boston: Houghton Mifflin.

Kundera, M. 1991. Immortality. New York: Grove Weidenfeld.

Maring, G.E. 1972. Pedestrian Travel Characteristics. *Highway Research Record,* Vol.406, pp. 14-20.

National Cooperative Highway Research Program (NCHRP). 2000. Implementation of the AASHTO Strategic Highway Plan, "Initial Draft of a Compendium of Strategies. NCHRP Project 17-18(3).

Older, S.J. 1968. Movement of Pedestrians on Footways in Shopping Streets. *Traffic Engineering and Control,* No. August 1968, pp. 160-163.

Transportation Research Board. 1985. Highway Capacity Manual, Special Report No. 209. Transportation Research Board.

Untermann, R.K. 1984. Accomodating the Pedestrian. New York: Van Nostrand Reinhold Company, Inc.

MANAGING COMPUTER-BASED ENVIRONMENTAL INFORMATION

Jun Xu
Dr. James Jones
College of Architecture and Urban Studies
Virginia Tech

I. Introduction

Recently, environmental issues in architecture have drawn increasing attention internationally. This is shown by various publications and research that present issues and design approaches aimed at environmental integration. Since the 1950s, concerns about both industrial pollution and energy supply were reflected in a greater and wider interest in the life cycle of nature and renewable resources. Olgyay, McHarg, and other researchers pioneered the study of arcology, a design theory and method based on architectural implementation of the environment. Their revolutionary principles emphasize the basic aspects of the natural environment, including climate, physiography, hydrology, vegetation, and the lives of the inhabitants, in addition to traditional aesthetics (fig. 1).

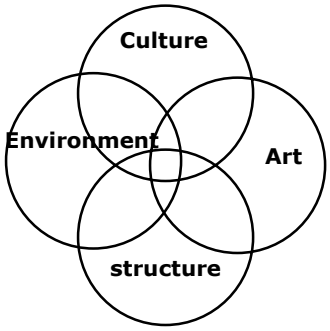


Figure 1. Design integration

As both an alternative and complement to contemporary environmental design, feng-shui is a Chinese geomancy that examined the sites of cities and determines the desirable layouts of buildings. Currently, architects of many major projects in Western societies have relied on input from the feng-shui experts before construction begins. But even Chinese, who are familiar with ancient eastern literature and philosophy, often have difficulty understanding the basic feng-shui concepts and methods of application. Feng-shui is based on a set of values different from current technology and lifestyles; they are approved historically by the ancient examples in Asia, Africa, and the Middle East.

As the result of a need to include ecological principles in the design process, many computer tools are now available that allow climatic factors, such as temperature, solar radiation, and wind to be analyzed, and provide guidance for their proper utilization. Other computer tools analyze the physical environment. However, it is often difficult to balance the many considerations for the climatic and physical factors. On the other hand, land information such as zoning and utility maps, aerial

photographs and topography maps are now available for many locations in electronic format. More and more often this information can be accessed over the Internet. This creates an opportunity for these information sources to be downloaded and combined into a digitized format for viewing and comprehensive analysis.

This paper presents a framework and approach for managing both contemporary and traditional environmental information with a computer-based tool (fig. 2). This tool will be focused on the site evaluation process. There are three major components of the tool: the graphical user interaction (GUI) component, the environmental analysis component, and the conversion component. The graphic module will act as a preprocessor and postprocessor for the analysis component. The environmental analysis module is actually the integration of several software packages. By applying the feng-shui principles, results from those packages are converged to derive the conclusion. The conversion component allows inputs from GUI to be converted into formats recognized by the analysis software packages. Meanwhile it allows the outputs from the analysis packages to be converted into formats displayable on the GUI.

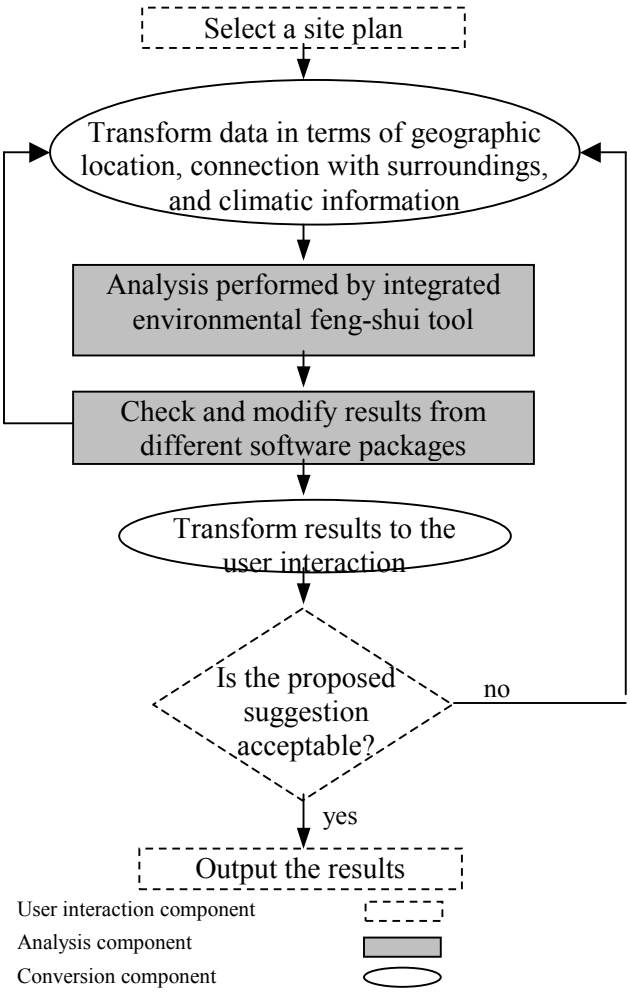


Figure 2. Flow chart of the integrated environmental information management tool.

Using feng-shui principles, the first phase of the research seeks to establish a combined analysis approach that may lead to a better understanding of the relation between humankind and the natural environment, and create harmony and equilibrium between them. The implementation strategy can be found in the concept of a rule-based information system -- a computational information representation system based on a structured database -- where each rule is established based on both western and eastern principles.

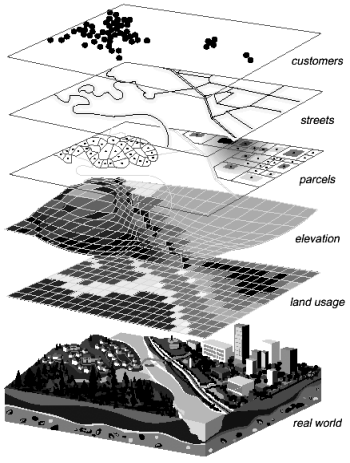
II. Design Rule-based System

Rule-based systems emphasize reasoning based on certain hypothesized rules. Archetype analysis, style characterization, shape grammar, and expert systems are new developments regarding design by rules. Combination of rules can be further used to support case-based design, knowledge-based design and more sophisticated expert systems.

There are three steps to establish a rule-based system. The first step is system design. The nature of the rules used by McHarg and Hendler indicates both sequential and hierarchical organization could be applied in establishing a rule-based system. Next step is to identify the rules. In our research, each rule is established based on both western and eastern principles. The third step is to apply these rules to a layered information structure. The methods used by McHarg and the application of GIS tools has already shown the possibility of integration of the rule-based approach with the design process. McHarg

demonstrated the result from each analysis in a transparency and attached them together to get the summary. Similar concepts can be seen from the design of computer tools: ArcView GIS from ESRI separates the information in layers and supports the users to apply rules in its analytical functions (Fig. 3).

a) Maps for analyzing the factors in McHarg's research (McHarg, 1969)



b) In ArcView GIS, rules can be applied to one layer or several layers simultaneously (http://www.esri.com/software/arcview)

Figure 3. Similar concepts to apply rules in layered information structure

However, many issues still need to be considered to apply the rule-based approach with the digitally represented information. Research about the functions supported by the computer tools is also very important. Then the implementation of the rules may combine several existing functions together or new functions should be developed.

III. Transform Feng-shui Methods into Computerized Components

Basic Theory of Feng-shui

Literally, Feng-shui means wind and water. It is the Chinese geomancy that examines the sites of cities and towns, and determines the layouts of buildings and graves. It has been used by Chinese since the Zhou dynasty (1066-771 B.C.).

The basic theories of feng-shui include the Yin-yang theory, the energy flow (Qi), the five characteristics, and the eight trigrams. Each of these is highly related to others and could be interpreted flexibly if conflicts exist. A brief interpretation of each characteristic is listed as follows:

Yin-yang theory is the fundamental principle presented in Qi, five characteristics, and the eight trigrams in feng-shui. Based on the observation of the universal energy of the earth, the ancient Chinese believed that everything in the universe was produced by changes, the results of yin and yang balance. Yin (- -) symbolizes the moon, the female, the dark, and the stillness; while yang (—) symbolizes the sun, the male, the brightness, and motion.

Qi can be translated as vital energy flow. It is the most important concept in feng-shui as well as in other forms of traditional Chinese culture. The simplest feng-shui concepts consists of Qi arrangement. In housing design, when Qi is abundant, the site will bring health and strength to those who live there. Qi could be influenced by orientation, land form, wind, water, and the surrounding environment of the site.

The five characteristics include metal, wood, water, fire, and earth. The ancient Chinese believed that everything has an attribute regarding the five

characteristics, which influence each other within a certain order: a creative order and a control order.

The eight trigrams -- heaven, water, mountain, thunder, wind, fire, earth, and lake -- are derived from the changes of yin and yang. They also represent the eight directions, four seasons, and times of the day. Figure 4 shows the ba-gua, a feng-shui diagram made up of the eight trigrams combined with feng-shui numbers and eight directions. Ba-gua is the central part of the feng-shui compass, and is the basis for both the form school and the compass school.

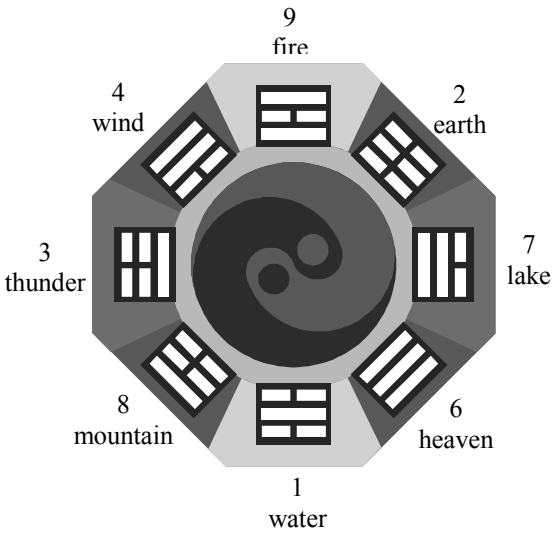


Figure 4. Eight trigrams in ba-gua

Practicing Feng-shui

The selected rules are mostly derived from Yang house of feng-shui, which is for buildings, towns, and cities. Only limited principles from the Yin house of feng-shui, which is applied to tombs, are selected as the supplemental material. The selected rules are also derived from two feng-shui schools: the form school, based on the land form and the Qi related to these forms; the compass school, based on astronomical changes and calculations with a feng-shui compass.

The feng-shui methods of the selection of housing sites in a countryside can be summarized in the following four principles:

1. The principle of systematic analysis is the foundation for the selection of other principles. Every factor within the environmental system is related with others. Some of them may have conflicts at one moment, but they can be transformed to others in certain conditions. The goal of using feng-shui principles is to find an optimized balance of all major factors.
2. The site should be supported by vital Qi. For example, a favorable site should be surrounded by good hills and water. Topographic analysis, dealing with forms of land, for a specific site should be considered in addition to the regional information.
3. A favorable site should have a good orientation, such as facing south for those located in China.
4. Geologic and hydrologic data can provide more detailed information sets to perform the physiographic analysis.

The above rules are interpreted based on several assumptions, such as 1) topographic factors are the most important when evaluating mountains and hills, 2) water-flow patterns are the most important factors when evaluating the influence of a body of water, and 3) the orientation is directed by the feng-shui compass used in the form school. It should be also noted that conflicts and debates exist when applying feng-shui rules because of the flexible practices and ambiguous literature. In this research, the most commonly used texts are selected to support the interpretation.

Interpret Rules in GIS

Literature shows that the ancient Chinese summarized the basic feng-shui principles into illustrated patterns from the form school. Figure 5 shows two patterns with the same contents: the left

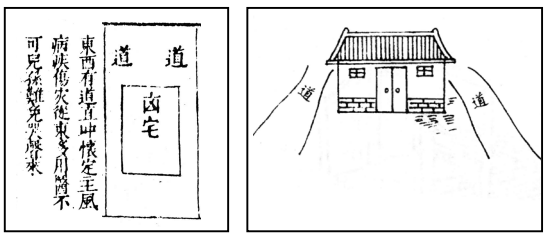


Figure 5. Two patterns show the same contents -- straight roads on both side of the house will bring too strong wind onto the site.

was first published in the Ming dynasty (1368-1644) (Wang 1985), and the right was a new interpretation (Wang 2000). After more than three hundred years, the patterns are still used today, but with no certain sequence and no connection with current technology.

Practically, these patterns can be transformed into computerized diagrams. For example, two roads and a house in figure 5 can be interpreted in GIS as the adjacent relation between road and house objects. More examples can be seen in figure 6. Arcview GIS is a mapping software that links information in layers. The digital map created by GIS has points, lines, and small areas, representing features such as cities, roads, and lakes, respectively. The information database stores data on layers and users can activate layers based on their needs.

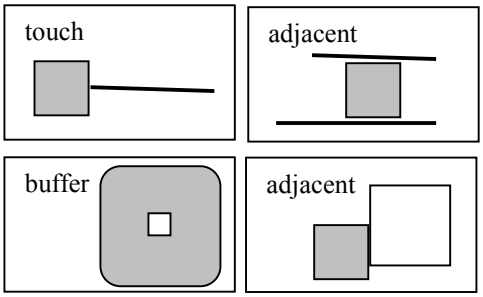


Figure 6. Relations between objects

The following maps show the detailed analysis of possible housing sites in Blacksburg, VA with general feng-shui rules.

- South facing site is favorable. With a digital elevation map (DEM) (Fig. 7), it is easy to compute the change in elevation and slope by assigning a numerical value between 0-255 to each cell, corresponding to a shade of gray (Fig. 8). The favorable site can be located as the dark portion on the map.
- An ideal site should not be on a steep slop, nor at the lowest point in the area for avoiding potential flooding and drainage problems (Fig. 9). The top of the mountain or a ridge should not become an option because of lack of protection (Fig. 10).

When applying these constraints together, the final results in Figure 11 show the possible solutions.

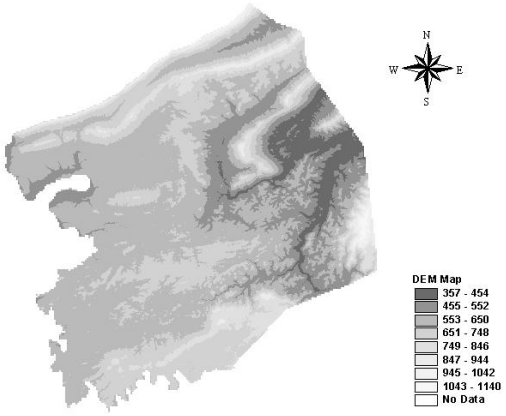


Figure 7. Digital elevation map (DEM) of Montgomery County, VA

Figure 8. Hillshde map shows a relief perspective

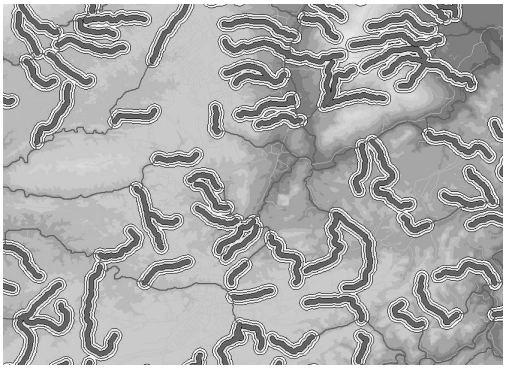


Figure 9. Avoid flooding area

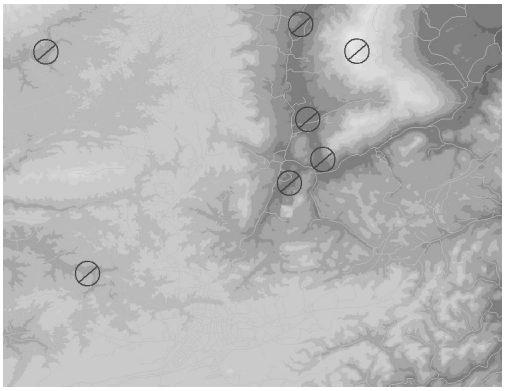


Figure 10. Avoid the lowest point of the surroundings and the top of the hill

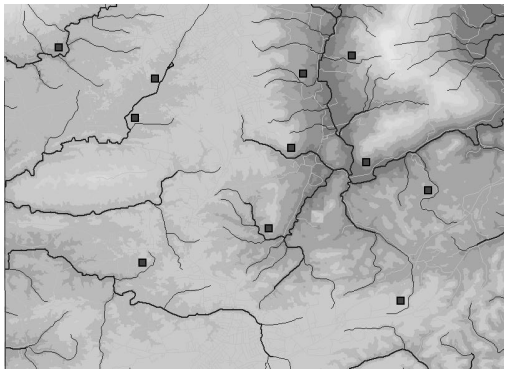
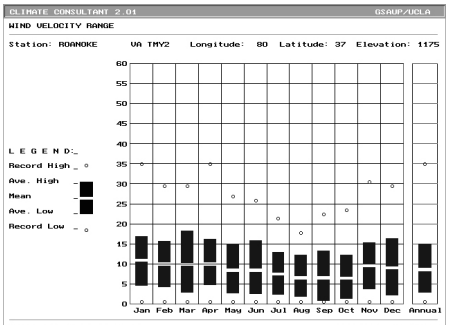


Figure 11. Possible solutions of favorable sites

needs, sun charts and sundials. Based on the passive design strategy as outlined by Givoni (Givoni 1981) and Waston (Waston 1992), it also provides psychrometric analysis that recommends the most appropriate zone.



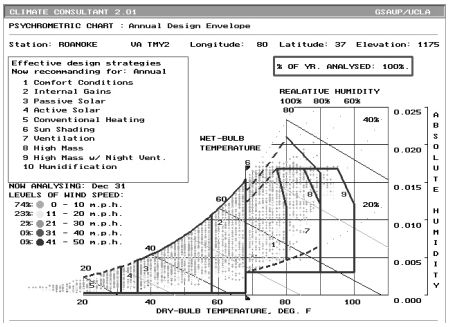


Figure 12. Analysis chart in Climate Consultant

IV. Manage Computer-based Environmental Information

Five groups of data are significantly important in our research: climatic information, topography, geology, hydrology, and vegetation. Managing these information is a two-step process. The first step involves information collection. We need to collect the necessary data, define the research boundary, and set the unit system. Then the data will be converted to a common format. These are adapted to three sequential procedures: converting data, verifying information and correcting data, and deriving new data sets.

Figure 12 shows a weather data chart in Climate Consultant. Climate Consultant was developed by the School of Arts and Architecture of the University of California at Los Angles. It can graphically display climate data, including temperatures, wind velocity, sky coverage, timetable of bioclimatic

However, it lacks a linkage between Climate Consultant and GIS. Figure 13 shows the rainfall map of Curry County, OR. One challenge of the proposed work is to convert data between different computer software packages.

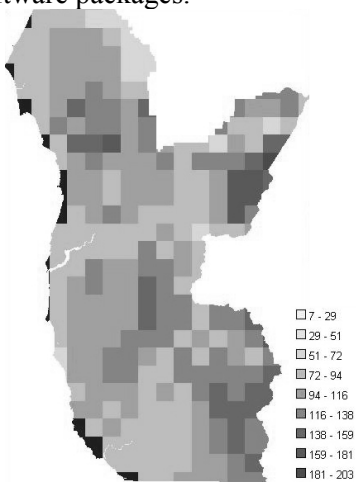


Figure 13. Rainfall map in ArcView GIS

V. Future Development

The managing of environmental information is helpful to enable students and professionals to learn and apply the knowledge in the design process. The concept can also be used to create other architectural related systems such as constructional systems and HVAC systems. Therefore, each information system becomes a component in the whole process, and the incremental expansion of these sub-systems can be further developed into an integrated design decision-making system. This is the first step toward the broadly focused objective.

Reference:

- Crump, R. and Harms, M. (Eds.) 1981, *The Design Connection: Energy and Technology in Architecture*, New York, NY: Van Nostrand Reinhold Co.
- Chen, J.J. and Kong, S.P. 1999, *Feng-shui and Architecture*, China: Jiangxi Science and Technology Publications
- Eitel, E. J. 1993, *Feng-shui: the Science of Scared Landscape in Old China*, Tucson, AZ: Synergetic Press Inc.
- Givoni, B. 1981, *Man, Climate, and Architecture*, New York: Van Nostrand Reinhold
- Gu, L.T. eds. 1995, *Collection of the Secrets of Geographic (Di Li Tian Ji Hui Yuan)*, Taipei: Wulin Press Ltd.
- Hendler, B. 1977, *Caring for the Land: Environmental Principles for Site Design and Review.* Chicago, IL: American Society of Planning Officials.
- McHarg, I. L. 1969, *Design with Nature*, Garden City, NY: Natural History Press
- Olgyay, V. 1973, *Design with Climate: Bioclimate approach to Architectural Regionalism*, Princeton, NJ: Princeton University Press
- Wong, E. 1996, *Feng-Shui: the Ancient Wisdom of Harmonious Living for Modern Times*, Boston, MA: Shambhala Publications Inc.
- Wang, Q. 2000, *Study of Ancient and Modern Feng-shui*, China:Yunnan People Press
- Wang, Q. H. 1999, *Research of Feng-shui Theory*, China: Tianjing University Press
- Watson, D. and Labs, K. 1992, *Climatic Design*, New York: McGraw-Hill Co.
- Xu, P. 1990, *Feng-Shui: A Model for Landscape Analysis (China)*, Dr. Dissertation, Boston, MA: Harvard University
- http://www.esri.com/software/arcview/

Sustainable urban designs for Asian cities: economic reality and technological choices

By S.Ganesan
Department of Architecture,
University of Hong Kong

Sustainable urban designs – a realistic resource base

The object of this paper is to generate design approaches that respect a realistic mix of foreign and local resources for sustainable urban design and construction in high-density Asian cities. In order to evaluate this goal at the level of projects, this paper argues that urban designers have to consider within an interdisciplinary frame, technological choices, their environmental implications as well as the foreign resource content of projects.

The general goals and specific objectives of sustainability are embodied in Agenda 21, the United Nations action strategy for sustainable development. In practice, the central goal is to achieve economic goals and social equity without environmental degradation (OECD 2000). The potential conflict is even more serious in the developing countries (DCs).

Researchers on sustainable designs have failed to state explicitly that in the context of developing urban territories, the foreign resource content of projects should match the nation's ability to repay debts incurred in their implementation. For example, ecological modernisation in its present form largely focuses on environmental problems of the affluent Northern hemisphere (Blowers and Pain 1999). Sustainability in economic terms should include a nation's ability to repay foreign loans secured for urban project financing.

Choice of technology for project is central to understanding resource implications. Urban designers have influence over two interrelated areas in particular which impact critically upon technological choices and resource implications: (i) spatial arrangements and infrastructure provisions; and (ii) resources embodied in detailed designs or used in construction of the infrastructure and built forms. In practice, any discussion of choices, e.g., for infrastructure projects, embraces both areas (i) and (ii) above, Kibert *et al* (2000) argue that for a fundamental shift from a non-renewable basis to a renewable system in the way materials are designed, first, buildings have to be constructed so that components can be decoupled and recycled; second, use of renewable energy sources should be increased.

This analysis is concerned about the level of foreign exchange used up for building new projects in particular. Foreign exchange is vital to purchase all foreign

resources- energy, finished materials, raw materials for local manufacture, etc. Foreign exchange is in limited supply in all the DCs. This paper uses the terms foreign resource content (in projects) and foreign exchange content interchangeably. The paper hypothesizes that pursuing sustainability goals in the DCs concurrently from the dual angles of preserving natural resources (Kibert *et al* 2000) and conserving foreign exchange reserves, is likely to produce design guidelines that are compatible with the goals set out earlier.

Ganesan (2000a, pp. 6-21) discusses the applications of optimization models to demonstrate that designers in DCs will have to use a mix of foreign and local resources, so as to maximize *total* volume of construction. This state of maximization represents a unique technology appropriate for the pattern of resources available to the whole industry. Subject to satisfying this unique condition, strategies for individual projects may be flexible in terms of the scale of projects, the mix of local and foreign materials and services employed on the project, the method of execution, as well as the share of local and foreign capital used in financing the project. Inappropriate technologies transferred into DCs end up absorbing too much of limited resources available, e.g., foreign exchange reserves and invariably limit the growth of the total industry (Ganesan 1979; Abbott 1985, p.19). Ideally, projects funded mainly from foreign resources should normally generate a part of the revenues in foreign currencies, in order to service foreign liabilities. Otherwise governments have to guarantee debt servicing, drawing from other sources of foreign currency income.

Technological choices for urban design

For individual projects, three approaches are available. The first option is to adopt large scale technologically efficient solutions, such as a large water purification plant and water distribution network, or a pipe borne sewage treatment and disposal system, or large capacity incineration plants for waste disposal and recycling. The technology is being constantly refined. The second approach embraces technologically advanced projects of small to medium scale, where the inputs and outcomes are designed to be harmonious with nature. The Public Works and Government Services Canada (PWGSC 2000) lists 90 "environmentally-appropriate " practices in this category, related to water conservation, waste management, recycled materials, indoor air quality, etc, applicable to commercial building and multi-unit residential buildings.

There is little evidence that these solutions are affordable in developing countries, in terms of either the total cost in local currencies, or the foreign exchange content involved. For example, indoor air biofilters, flyash concrete, building-integrated photovoltaics, cogeneration, reinforced grass paving systems are technologies that embody concepts apparently attractive to developing countries, however, their applications turn out to be costly and problematic(PWGSC 2000; Ganesan 2000a). There are some exceptions. Solar heating panels, e.g., could be adopted on a large scale with considerable benefits.

Solutions developed by advocates of cheaper technologies for development, such as the Intermediate Technology Development Group, London, constitute the third category. The technology adopted is either an innovation based on traditional technologies, or advanced technical solutions available on a small scale; the products are thought to be

affordable and require limited foreign exchange. Improved septic tanks for sewage treatment or soil cement building blocks are two examples. High-density urban settlements require large scale integrated services. The first two approaches outlined above demand large expenditures in foreign currencies, and there are physical constraints in adopting many solutions proposed under the third approach.

Lessons from the 1997 Asian Crisis

The 1997 Asian economic crisis was a crisis in allocation of resources and provides empirical evidence to substantiate the preceding arguments. Ganesan (2000a, pp.30-70) reviews the available evidence in considerable detail. Too much foreign debt was incurred and used on domestic projects that failed to generate adequate foreign currency revenues required for repayments. Many of these were construction and real estate projects in large urban locations such as Manila, Bangkok, Jakarta and Seoul in South Korea. The foreign exchange content in many urban ventures such as high rise office and commercial buildings, hotels, and luxury residential blocks reached up to 75% of total project cost; foreign liability was built up largely through commercial loans for project investments, and expenditures incurred through imports of finished materials and equipment, and imported raw materials and energy for domestic building materials production. The revenues in foreign currency earned in many cases were well below the investment level. Apart from increasing foreign debts, these projects also drained away valuable foreign exchange reserves in these countries, leading directly to a loss of confidence in local currencies, collapse of the exchange rates, a foreign exchange crisis and economic shrinkage. Measured in US$ terms, the above cities suffered close to 50% reduction in the volume of urban design and construction activities in the years that followed the crisis. The hypothesis that a developing country can borrow for and in general maximize foreign investment in urban projects stands thoroughly discredited after the 1997 Asian Crisis (Ganesan 2000a). In any event, borrowing excessively and passing the burden of repayment to future generations conflicts with the fundamental concept of sustainability.

What designers need to do in Asia?

Typically, the most important goals facing urban designers in high density urban areas are to achieve a more balanced land use and built form in the high density districts, increase volume of infrastructure and housing construction, provide more efficient transport and reduce traffic congestion, reduce pollution of air, water and land, promote recycling of waste, build more energy efficient spaces and seek greater harmony with the ecosystem. Take Hong Kong as an example. Designers' ability to respond to these challenges is being hampered by three difficulties in Hong Kong. High population densities (up to 3000 persons per hectare), limited supply of buildable land, and a high consumption model dictated by a per capita income close to US$25000 (Ganesan 2000b). Hong Kong has reaped massive economic benefits of concentrating highly skilled people within a relatively small area, while generating huge agglomeration benefits. In consequence, Hong Kong is clearly able to afford advanced technological solutions without any foreign resource constraint, and designers can look upon any constraint as an opportunity for innovative solutions, such as,

for example, the "mega city model"(Hyper Building Research Committee 1997).

Practically all major cities in Asia (including China and India) experience the serious problems of Hong Kong in varying degrees, however, without being endowed with comparable levels of financial resources, for example, Chongqing in China (Chongqing Urban Environment Project 2000). The per capita income in these cities is low in the range US$ 500-3000. Poor environmental quality in these cities has recently emerged as a serious deterrent to overseas investors. Sustainable urban design guidelines should be sensitive to these constraints.

Design guidelines for residential and non-residential buildings

In theory, *essential* foreign technologies, material and equipment resources will have to be mixed with a mass of capital saving and labor intensive activities to achieve high volume construction targets. In practice, this means large scale training of skilled workers and managerial workers, expansion of domestic capacities for manufacturing of building materials, increased use of local raw materials in such units emerge as the more important strategies from research using optimization models (Ganesan 2000a). Many developing countries are attempting to adopt such approaches, but have had only limited success in minimizing the foreign exchange content in housing designs, because of rising costs of oil and essential materials. Modern (international style) buildings such as luxury hotels and office blocks continue to use a high volume imported materials and equipment. The foreign exchange content in such projects can be reduced to less than half the total cost if design and construction are undertaken by joint ventures of foreign and local firms(Ganesan 2000a).

Infrastructure and Environmental Construction

Most countries possess technologies to deal with basic infrastructure needs such as highways, water supply, sewage disposal etc, The insurmountable challenge at present is posed by demands arising from the poor environment, such as recycling and waste minimization, pollution control, controlling energy use and dissipation, cleaner transport systems, etc. Imported technologies that promise a solution appear to use too much foreign resources and are in the medium to long term simply unsustainable. A total solution to these problems calls for a national multi-sectoral effort. However, urban design itself has some contribution to make. *First*, urban designers from their perspective have to propose spatial solutions that prevent or minimize the occurrence of these environmental problems. *Second*, they have to advance solutions that optimize the use of foreign resources and bring about a sustainable resource base in urban construction and without leading the countries towards another Asian Crisis. Designers have to adopt a sustainable mix of technologies (selected from the three categories discussed above). This paper advances below some practical measures based on the above approach, for adoption during large-scale urban design and renewal.

Transport infrastructure and mobility costs

Urban designers in Asia should consider implications of land use transport interactions in greater detail than in the past. Especially with regard to air quality.

Applying principles of sustainability to transportation will reduce pollution generated by gasoline-powered engines, noise, traffic congestion, land devaluation, urban sprawl, economic segregation, and lead to lower transport costs for the commuters (Commission on San Francisco 1997). Specifically, less reliance on automobiles and improved facilities for pedestrians and bicyclists are advocated (Huyink 1995; the Department of the Environment 1996; Crawford 2000.). This approach may work well in small to medium sized cities. Transport planning in any form becomes almost unmanageable in high density locations, with rising employment and incomes. Conversion of public vehicles to cleaner fuels (e.g. natural gas) will contribute to atmospheric decontamination (Ganesan, 2000b; ICLEI and others 1999). It is essential that current subsidies to gasoline, driving and parking of automobiles be redirected to public transit and other alternative modes.

Energy efficiency

Major sources of energy consumption in Asia are heating and cooling costs of commercial buildings, and secondly, energy costs of transportation. Excessive solid and liquid wastage that remains without being recycled also represents a major dissipation of energy (Ganesan 2000b). Energy efficiency assessments should include energy dissipated in pollution and wastage. Many cities in Asia face a chronic shortage of energy to support increasing urban productivity in general; so much so, nearly 12% of household income is spent on energy (UNEP 2000). In 1997, the commercial users in Hong Kong took up 59% of total electricity consumption for space heating and cooling. In general, energy consumed in buildings depends on the building configuration and orientation, and on the efficiency of building envelope and services. Architects are engaging more energy efficient HAVD systems in modern buildings in Asia. Combined radiant heating and cooling systems, typically using heated or chilled water, are being investigated for use in commercial buildings without excessive heat gains. At the same time, urban designers ought to exploit the potential of the sun, wind and landscaping to minimize heating, lighting and cooling costs. Designs should use winds to reduce adverse micro--climatic changes and release air trapped in densely built locations due to the canyon effect of tall buildings (PWGSC 2000).

Air quality

Urban design should aim for lower levels of pollution especially for the residential locations. There are several approaches to achieve this: reduce traffic flow that depend on petroleum products; increase cleaner forms of transport such as electrically operated mass transit systems; and separate residential districts as far from heavy traffic as possible. Planning guidelines should provide a healthy balance between open spaces, trunk roads and housing allocations, such as to improve air quality in housing estates.

Poor quality of air outside contributes to lowering indoor air quality. Displacement ventilation methods, using 100% outdoor air, can help to remove pollutants indoor, where the outside air quality is of acceptable standard (PWGSC 2000). Operable windows instead of fixed windows can improve space conditions inside buildings at slightly higher costs. Outdoor air quality can be improved through transportation demand management,

land use planning and urban design (ICLEI and others 1999). Small communities in mixed-use surroundings need to be identified, and protected from exposure to traffic and pollution. This should be a goal of urban design.

Water conservation.

Domestic water consumption accounts for the major share of water demand in urban areas. Chronic shortages of water on tap especially in low income urban location and poor quality of drinking water are the main problems in most Asian cities. These cities are already suspected to be using more than their annual freshwater renewal rate on account of demands from non-renewable resources. Pumping of ground water for drinking purposes has limits due to intrusion of saltwater (UNEP 2000).

In general terms, however, conservation and recycling of water should help to maintain a balance between the water needs of the entire ecosystem and the huge demand for pipe borne water supply in urban locations. Conservation thorough low-level flush toilets and metering of supplies are already being adopted (ICLEI and others 1999).

The recycling of grey (waste) water can increases overall water supply capacities. As grey water can be recycled many times for different purposes, incorporation of advance technology for this purpose could be comparable in cost to developing fresh water supply schemes. The actual difference in costs in a particular city depends on the intended use of the recycled water such as bathing, cooking, cleaning or drinking, as well as on construction and equipments costs. In theory, demand for new water can be eliminated through repeated recycling, but the cost of this technology in less developed urban areas is likely to be more, in comparison to a large number of small scale small scale ground water pumping outlets that now serve many residential schemes.

Planning and implementing integrated wastewater collection and treatment systems is one of the major environmental expenditures looming. Many cities have been constructing sewers, but few are equipped with treatment facilities. Storm water discharge system has to be considered when planning urban sewage system (UNEP 2000). Economics of recycling will be greatly facilitated by proper storm water management (Commission on San Francisco's Environment, 1997). With the rapid increases in population in Asian cities, these are real needs, demanding heavy use of foreign resources.

Waste management and recycling

Disposing solid waste in open dumpsite or as landfill are the dominant means of disposal in Asia. The introduction of sanitary landfill is an urgent priority everywhere in the developing world (UNEP 2000). Even where complementary disposal technologies such as composting or incineration (waste to energy plants) are practiced, a landfill is still required and is the backbone of any sustainable disposal system. This is not only a colossal waste of often-irreplaceable resources, but also occupies valuable development land in urban areas (Ganesan 1999b). The fundamental approaches to reducing waste are 1) to reduce waste generation, 2) to promote recycling, and the purchase and use of goods from recovered materials. Recycling and reuse are significantly more labour-intensive than garbage hauling, and create a new source of jobs in collection, processing, and repair or manufacturing (Commission on

San Francisco's Environment 1997). Effective waste management will also lead to measurable reductions in the massive ecological footprints generated by cities such as Hong Kong. Urban design should allocate space for waste collection, incorporate tools for segregation of waste as desired and recycling centers uniformly.

Strategies to conserve water and energy can also lead to public, residential and industrial waste prevention.

Construction waste

Construction waste is an unusually serious problem in Asian cities with high volumes of urban construction and renewal programmes. Based on the Law for Recycling of Construction Waste, Japan's contractors are obliged to segregate at the sites demolition and construction waste for recycling. The Government also promotes the use of recycled materials and the design of high durability housing systems in public projects (Ando 2000). Urban designers in Asia should provide for taller buildings, using more durable materials and incorporating flexible partitions and high-tech features that are likely to prolong the economic life of buildings. Increased manufacture of components off-site minimises waste during erection of structures.

Conclusion

Notwithstanding the numerous difficulties discussed above, a high density compact environment that minimises wastage and pollution may be an ideal form for Asian cities. Design strategies that seek harmony with nature, and at the same time optimise on foreign exchange use, are complementary to one another. Such designs will in effect prevent the build up of pollution and wastage, and excessive dissipation of energy as seen today. A mix of technological solutions will be needed. Available foreign resources should be diverted to critical infrastructure and environmental projects, where local technologies are yet unable to satisfy the need. Substantial project economies can be achieved by employing joint ventures of foreign and local firms for design and construction of such projects. Non-critical projects should be executed using largely local resources. The classification of projects in a city under these two categories should be determined through research.

References

1. Abbott, P.G. 1985. *Technology Transfer in the construction industry*, The Economist Intelligent Unit, London.
2. ANDO, Shoichi. 2000. *Japanese Policy on Sustainable Building*, Conference on Sustainable Building 2000, Maastricht, Netherlands, October 23, 2000.
3. Andrew Blowers and Kathy Pain, The unsustainable city? in Steve Pile, Christopher Brook and Gerry Mooney (eds.),*Unruly Cities?: Order or Disorder*, London: Routledge.
4. Donald A. Brown. *The Role of States in Sustainable Development Programs in the United States*, A Report Presented at the National Town Meeting on Sustainable Development, Detroit, Michigan, May 4, 1999.
5. *Chongqing Urban Environment Project:* 2000, China Department of the World Bank, Home Page of the World Bank, 2000.
6. Commission on San Francisco's Environment, *Sustainability Plan for the City of San Francisco*, San Francisco, 1997.
7. J.H. Crawford, 2000. *Carfree Cities*, International Books.

8. Devapriya K.A.K. and Ganesan, S. 2000; Technology Transfer through Subcontracting in Developing Countries; *Proceedings*, The 2nd CIB-TG29 International Conference on Construction in Developing Countries, 15th-17th November, Botswana, South Africa.
9. S. Ganesan, 2000a. Employment Technology and Construction Development (With Case Studies in Asia and China), Avebury: Aldershot U.K., 392 + xxi pages.
10. S. Ganesan and S S Y Lau, 2000b. Urban Challenges in Hong Kong: Future Directions for Design, *Urban Design International,* 2000, pp.3-12.
11. Hyper Building Research Committee, 1997, The Building Centre of Japan. (http://www.or.jp/bcj/)
12. ICLEI and others (International Council for Local Environmental Initiatives, the Municipality of Santiago and the Corporation for the Development of Santiago) (1999) *Sustainable Santiago Public Report February 1999*.
13. Information Technology Specialists (ITS), 2000, *the Residential Energy Efficiency Database (REED*), Home page on the WWW.
14. Kibert, Charles J, Sendzimir, Jan and Guy, Brad (2000), Construction ecology and metabolism: natural system analogues for a sustainable environment, *Construction Management and Economics*, 18,903-916
15. Ministerial Council Meeting, Organisation for Economic operation and Development: OECD, 2000. *The OECD Initiative on Sustainable Development: Progress Report*, Paris.
16. Public Works and Government Services Canada and others (PWGSC)(2000). *Advanced Building Technology and Practices*, Home Page on the WWW.
17. The Department of the Environment, 1996, Sustainable Settlements and Shelter, London: HSMO.
18. United Nations Environment Programme: UNEP, 2000, *Environment Technology,* Homepage on the WWW.
19. Huyink, R 1995. Integrated town planning and traffic policy in Groningen, Sylvia Trench and Taner OC (Eds.) Current Issues in Planning, Aldershot: Avebury.

MAKING A SMALL TOWN LIVABLE: PROMOTING SUSTAINABILITY THROUGH A NEW URBANIST APPROACH IN MEBANE, NORTH CAROLINA

Fatih A. Rifki, Ph.D. *Associate Professor of Architecture, College of Design, School of Architecture, NCSU.*

Umut Toker, *Ph.D. Student, College of Design, School of Architecture, NCSU.*

Zeynep Toker, *Ph.D. Student, College of Design, School of Architecture, NCSU.*

Abstract

A contemporary nexus of urban development discussions is the concept of sustainability, which is often presented as a viable remedy to many of the contemporary urban ills, i.e., diminished livability that is mostly blamed on suburban sprawl.

Not only large metropolitan areas experience sprawl. Numerous relatively small towns have also been undergoing this kind of spatial transformation as their cores are emptied in favor of suburbs. Town of Mebane, North Carolina, is one such small town.

Today, downtown Mebane is home to manufacturing plants, retail stores, institutional buildings, and residences as well as empty lots and boarded-up buildings. Its architectural scale is still charming and its gridiron network of streets is capable of accommodating various modes of traffic although precedence is given to the car. Furthermore, some of the downtown buildings are worthy of consideration as historic landmarks, although many have been clad with metal panels, disguising their authenticity.

This paper is a progress report on the first of three phases of an urban design **action-research project** on downtown Mebane, being undertaken by NC State University Architecture Faculty and Doctoral Students. The goal of the project is to generate sustainable urban development principles, guidelines and standards that promote urban livability. This phase involves an inventory of the town's physical, social, environmental and economical resources with New Urbanist "lenses" to develop specific sustainable urban development goals for the town's future and strategies to achieve these. In the subsequent phase of the project, proposals will be developed with citizens' input through citizens' charettes. It is envisioned that the process and the consequent proposal developed for Mebane is presented as a model to other small North Carolina towns that are striving to alleviate many of the ills of sprawl in the last phase of the project.

Introduction

Urbanism is at a unique and unprecedented point in its history. There are profound questions about future growth and development patterns of human settlements. Responses to these questions will help determine urbanism's economic vitality, extent and health of social interactions it initiates and sustains, and its compatibility with the natural environment, i.e. quality of life for the present as well as the coming generations of city-dwellers. In this regard, one of the most fundamental issues faced in contemporary urbanism becomes whether the currently dominant spatial structure of urban development in the U.S. and in many other parts of the developed world, should still be allowed, let alone encouraged.

The physical characteristic of contemporary cities' growth patterns since the beginning of this century, but particularly after the World War II, is often referred to as "suburban sprawl". Such spatial patterns although dominant in major metropolitan areas, are not limited to large cities but can be found at small and medium scale of human settlements. In order to explain why such a generalized claim can be made, the discussion of urban development patterns needs to be taken beyond the somewhat pejorative term "sprawl" and the characteristics of the prevalent urban spatial structure with its consequences explained.

Current Urban Morphology

The characteristics of the current urban morphology found in many parts of the U.S. and the rest of the developed world are low density and segregated land uses, with a strict hierarchy of streets and roads in the urban area's transportation network (Langdon 1994). This network, designed according to standards predominantly dictated by moving motor vehicles, naturally gives precedence to private automobile. Furthermore, in this dominant urban development pattern, the line of demarcation between where urbanization begins -or ends- is not clear. Human settlements just ooze into their hinterland. Similar to not having an edge to urban development, it can be argued that the developed area does not have a focus or a center. Neither does it have a sense of place that distinguishes one settlement from the other near or far. These generalized attributes of urban sprawl are elaborated upon below:

Low density: Whether in housing or in commercial and institutional uses, but particularly in retail and employment centers, low density growth pushes the developed urban area deep into agricultural and natural ecosystems. In many cases fertile farming land and open space -with the beauty and drama of the landscape- that once surrounded the urban area are lost (Goldfield and Brownell 1990). In others, fragile biological systems, e.g., wetlands and animal and plant species, are endangered. The most apparent physical evidence of the low density is the seeping of the urbanized are into the rural **without a boundary**, as one new project leapfrogs another. The loss of open space yields consequences that are irreversible whereas the consequences of lost farmland can only be compensated by bringing new land into agricultural production, but often at high economic and environmental costs. Encroaching urban sprawl on rural farming communities can be devastating. For one, as these are transformed into "bedroom suburbs," their original stable socio-economic structure is changed forever.

Segregated land uses: One of the most distinguishing characterizations of contemporary suburbia in the U.S. and developed countries is how land uses are separated from each other into distinct and segregated locations, usually by heavily used arterial roads or open space. Such specialization of land utilization in many instances is taken to an increasingly finer scale within a given single project as well. For example, within a residential development, single-family dwellings on large lots are segregated from higher density multi-family complexes of the same neighborhood. In employment centers service oriented uses are disassociated from retail uses. One major consequence of this spatial pattern in housing is the resultant socio-economic uniformity of residential subdivisions where people of very similar income and family composition tend to congregate mainly due to the fact that individual dwelling units are virtually of the same specifications and hence cost (Kunster 1994). One other consequence of this separation is the loss of relationships between the different elements of the urban area. Every single land use is turned onto itself with barely any reference to its neighboring constituents of the urban area. As a result, there is neither a hierarchy nor is there a "center" around which urbanism is organized. Furthermore, the open space between the segregated land uses is a leftover or an after thought and not an intentionally designed urban element that helps shape community formation and identity, a **sense of place** (Duany et al 2000).

Strict hierarchy of roads in the transportation network: As suburban subdivisions are plotted, houses are usually clustered on cul-de-sacs or streets of lowest order in vehicular traffic carrying capacity, mainly to assure tranquillity and safety (Langdon 1994). These local streets are then linked to collectors or distributors that are themselves connected to arterials that circumscribe the development. Street widths, curb and sidewalk specifications, and parking provisions -all dictated by moving motor vehicles- also follow this hierarchy to match the projected level of roadway use in terms of volume and speed. The guiding concept of the hierarchical transportation network is that it

facilitates differing degrees of access within the development. For example, local streets provide access only to residents who live on them and thus carry very low volumes of traffic at relatively low speeds. The ubiquitous curvilinear geometry of the street layout of the contemporary suburbia typically requires relatively lower speed limits, which further contribute to the safety. The traffic volume and allowable speed increase as the transportation network moves from local streets to arterials. The highest order streets, i.e., arterials, are connected to regional highways at limited locations, in order to mainly discourage through-traffic. By the same token, pedestrian and biking paths are independent of, and often segregated from, motorized travel modes by providing exclusive pathways that rarely cross roads or streets.

Study Area

These generic characteristics of recent urban development are actually present "in-situ" in Mebane, North Carolina. This is a small town in the Piedmont region of the state. It is located roughly midway between two major metropolitan areas of the state, the Triad and the Research Triangle Park, which are connected by a heavily-traveled interstate highway simultaneously designated as I-85 and I-40. This highway is a few miles south of the town's downtown.

Town of Mebane is both a typical as well as a unique town. It shares many attributes with numerous towns in the region: It is a railroad town that sprouted form a stop on the east-west and north-south regional rail routes. It is also a manufacturing town as it was home to one of the major furniture factories in the state - White Furniture Company- until its closure more than a decade ago. It continues to be the host to various other manufacturing establishments and was seriously considered when Mercedes-Benz was evaluating various U.S. locations for its North American production facilities.

Today, the forces that initiate and sustain suburban growth are transforming Mebane. Its "downtown" is slowly hollowing out as residential, commercial, and institutional land uses locate to the outskirts of the town. The latest of these was the U.S. Post Office.

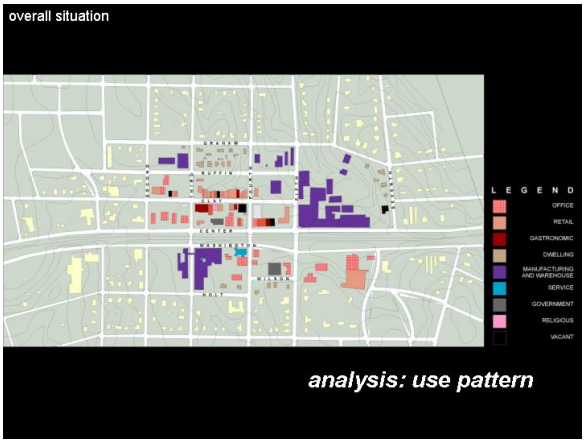


Figure 1. Mebane Study Area.

Against this backdrop, NC State University faculty and doctoral students initiated an action-research project that is aimed at helping the town move in the direction of a more sustainable future. A study area of 15 blocks in the center of the town was selected as the area of study. (Figure 1.)

This project entails three parts: It begins with an inventory and analysis of the physical attributes of the study area in the context of the entire town. The aim of this first phase is to develop goals and strategies that promote sustainable development of the downtown. The tenets of New Urbanism serve as the guiding principles for the strategies developed in order to achieve the goals. At this point in time this phase is being concluded.

The second phase of the project is a synthesis where proposals are to be developed. These proposals range from small scale improvements, such as streetscape enhancements using vegetation to devising design guidelines for physical development of the study area, e.g., how to serve the parking needs in downtown. A series charettes involving town hall staff and citizens are scheduled to institute an iterative proposal development process in this second phase.
In the last phase, lessons learned in the Mebane project will be used to develop a "handbook" for similar efforts in many other North Carolina small towns.

Phase One: Inventory And Analysis

In the analysis phase the following conclusions were drawn:

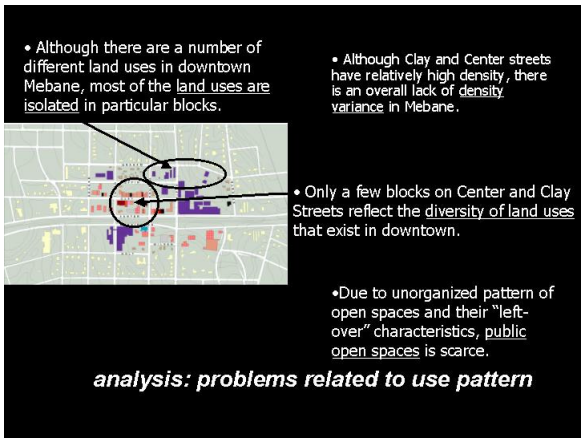


Figure 2. Problems Related to Use Pattern

The study area is rich in diversity of uses from residential in its north to manufacturing and institutional uses (town hall, police and fire stations) in its southern boundary. However, the land use diversity is locked in blocks -not at building- scale. Except for Clay Street, density is uniformly low across the entire study area. There are many vacant lots but there is a lack of designed open space. (Figure 2.)

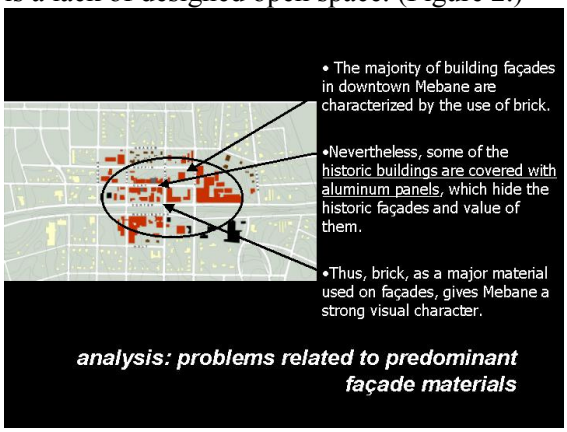


Figure 3. Problems Related to Physical Condition of Buildings.

Brick is the material of choice in the study area and this gives the place a character. There are numerous buildings in the study area that could be candidates for historic building designation. However many facades of commercial buildings have been covered with metal paneling. (Figure 3.)

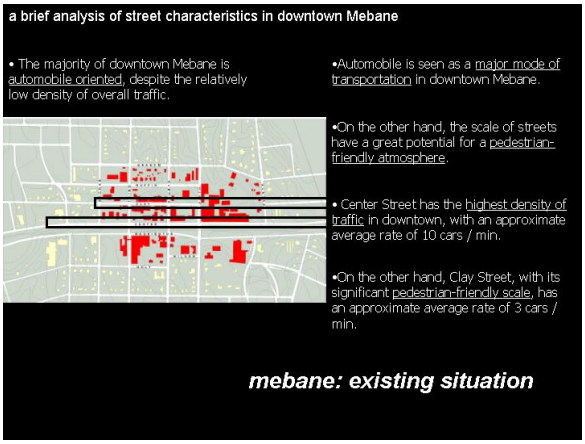


Figure 4. Problems Related to Accessibility.

It would not be a stretch to declare the study area an automobile oriented neighborhood. Furthermore, the railroad tracks that dissect the study area isolate the four blocks on the South side from the rest. Clay Street, which is home to diverse commercial uses, has a pedestrian friendly aura. (Figure 4.)

Phase One: Goals And Strategies

In light of the above inventory and analysis, the following goals were developed:

• Help downtown Mebane evolve into a lively destination:

Increasing land use density, developing innovative solutions to anticipated parking needs, and eliminating segregation of transportation modes are some strategies that would help achieve this goal. Furthermore bringing new land uses to the area such as a branch of the local community college and diversifying land uses at both urban design and building scales would be appropriate strategies.

• Exploit the location of Mebane between two major metropolitan regions of the state and the presence of the railroad that goes through its downtown, to make it a major transportation node.

Strategies for achieving this goal include encouraging alternative modes of transportation to and through the study area, and establishing a rail hub for commuters.

• Revitalize identity and urban life in downtown. Buildings in the White Furniture Company campus have worthy potential for adaptive reuse. Redesigning Clay Street into a pedestrian

promenade with the White campus as its terminus is an appropriate strategy for this goal. It should be noted here that since the action-research process employed in this project is not simply a linear undertaking but is made up of iterative loops, the above is not the complete list of strategies that help achieve those goals. Neither are the goals themselves are all there is. As the second phase gets underway new goals and strategies are expected to come out of the iterative efforts.

Conclusions

The above has been a "progress report" on this action research project. It is an outline of the first phase achievements. As the subsequent synthesis phase is undertaken to develop specific proposals, New Urbanism principles will be used as guiding posts. The ultimate goal to achieve at the end of this design phase is to propose a future for the downtown of Mebane that is:

• **Compact** with appropriately high land use densities;

• **Coherent** in its diversity of land uses;

• **Connected** in itself and to its context through various modes of transportation;

• **Contained** so that it has an identity that distinguishes it form its surroundings; and

• **Comprehensible** in having designed focal points and a sense of place.

References

- Brownell, B. and D. Goldfield. 1994. *The City in Southern History: The Growth of Urban Civilization in the South*. Port Washington, N.Y.: Kennikat Press.
- Duany, A., E. Plater-Zyberk, and J. Speck. 2000. *Suburban Nation: The Rise of Sprawl and the Decline of the American Dream*. New York: North Point Press.
- Kunstler, James. 1994. *The Geography of Nowhere: The Rise and Decline of America's Man-made Landscape*. New York: Simon & Schuster.
- Langdon, Philip. 1994. *A Better Place to Live*. Amherst: The University of Massachussetts.

Arcades: Investigating a Phenomena of an Urban Form

Nicholas B. Rajkovick & Alison Kwok, University of Oregon

Abstract

Urban arcades are glass-covered passageways that connect two or more city streets, lined on both sides by shops. Arcades host a multitude of activities such as retail establishments, serve as passageways for pedestrians between streets, and provide protection from inclement weather. This paper presents the background research and preliminary findings of a study into urban arcades.

This paper is divided into three sections:

1. A historical outline of the arcade, with examples of three existing arcades;
2. A presentation of recent research on the physical environment (sun, wind, light, temperature) in arcades;
3. A discussion of thermal comfort (ASHRAE Standard 55-1992) and its applicability to arcades.

The objective of this project is to show that arcades promote a "thermal diversity" in the city, allow for easier incorporation of mixed-use functions under a single roof, and function as common, public space on private property.

Introduction

As a building type and place of commerce, the arcade was a new, dominant form of the 19th century. Introduced in 1791 in Paris, the arcade sought to cover small shops with a modest skylight. (Geist, 1983) This changed mid-19th century with improvements in steel and glass technologies. These two materials became the basis for a new architecture, an unprecedented display of technology.

Under a clear, glass roof, both pedestrian and weather elements (sun, air) could penetrate the center of the densest city block. This eliminated the problem associated with a high concentration of people: dank, dark alleys. Arcades, as an urban form, were poised to reorganize the urban block and the modern city. However, before this potential was realized, the arcade disappeared.

There are many explanations for the fall of the arcade. Mumford finds fault with the arcade's "functional exactitude", citing that the arcade served only shopping, and was from the outset, unconvertible. (Mumford, 1961) The failure of downtown retail lowered the potential success rate of the arcade; businesses moved to suburban shopping centers.

Blake blames the fall on the ego of architects and developers, who are unwilling to share and develop common land in cities. Blake cites an unbuilt project by Philip Johnson for the Lincoln Center, an arcade idea was eliminated by other architects because they thought Johnson would be allowed to design all of the facades. (Blake, 2000)

MacKeith's explanation is that arcades fell out of favor as they lost their novelty, as covered shopping streets became commonplace. (MacKeith, 1986) To her, the availability of air conditioning and the increased number of arcades caused the arcade to lose its role as a unique space in a diverse city.

To these three authors, these problems killed a unique urban type. A new interest in arcades, and the renovation of historical arcades, has brought about a revival of the type. Several contemporary projects have proposed urban arcades, and a handful of new arcades have been built in the last ten years.

This frames two questions: *Is the arcade an appropriate form for rebuilding and enlarging city centers? If the arcade is appropriate, how does it deal with its past problems: mixed uses, public land on private property, and thermal diversity?*

A Historical Outline

An "arcade" is the translation of the German noun, *Passage*. Passage is borrowed directly from the French noun/verb, *passage*, and was in use as early as 1800 to describe the arcade type.

The root of passage is *passus,* the Latin for "step", conveying an element of movement and rhythm. All of the terms with a Romanic base, Geist states, have a common characteristic: "they express transition, threshold, passing, measured distance, or disappearance." (Geist, 1983) Geist defines the arcade as a "glass-covered passageway that connects two or more city streets, lined on both sides by shops." This definition represents the common use of the 19th century arcade, a center for shopping.

Arcade, thus synonymous with passage, describes a space with a beginning and an end, a thoroughfare linking streets.

In this sense, arcades are a "transitional" space, an internal artery connecting two or more external streets. Transitions through and over various types of thresholds are common as pedestrians move from street to street, or from sidewalk to interior shop. An arcade is a small, enclosed city, connecting shops together with a unique climate and street life.

This unique street life dates back nearly 2000 years, to Trajan's Markets, a center of commerce in ancient Rome. Under Trajan, in 100 A.D., the building was constructed next to the Forum, and housed shops under one roof. The central space, a basilica, was vaulted with large clerestory openings to admit light. This roof effectively covered pedestrians, protecting them from inclement weather. (Kostof, 1995)

This market hall was the predecessor for the arcade and the cathedral, linking in form commerce and religious activity. By the 11th century, European crusaders had carried this form to Jerusalem, where they constructed "souks". The souks were stone vaulted streets, adapted later into the Islamic bazaar and chan. (MacKeith, 1986)

In the Islamic city, the bazaar and chan were the city center. Along with the mosque, they functioned as the only public gathering spaces. The chan was the point where the trading caravan arrived, the warehouse and exchange center for bulk goods. The bazaar was generally located next to the chan, and was the center of day to day trading and retail. Widespread trade brought the arcade back to Europe in the Middle Ages, and market halls gradually increased in stature to accommodate the expanded production of guilds. The true arcade, however, would not appear until the 19th century in France, as architects adapted the bazaar form to the Parisian streets. (Geist, 1983)

The 19th century arcade was the result of the mass production of steel and glass, and a reflection of a shift in society. In the wake of the Crystal Palace, 19th century architects sought to use the language of glass and steel in their architecture. Mass production made luxury goods widely available and created a new middle class. The arcade served both, a symbol of its time.

The following three arcades are potential candidates for future study, a cross-section of 19th century arcades in size, function, and form. The issues inherent to these projects, effective mixed-use development, light and air to the middle of city blocks, and the anchoring of urban centers, are relevant concerns in designing the city of tomorrow.

The Galleria Vittorio Emanuele II, Milan, Italy

The Galleria in Milan was constructed between 1863 and 1867, the result of an open architectural

competition. The Galleria is cruciform in plan, covering the center with a glass dome equal in diameter to that of St. Peter's in Rome. The building connects Milan's cathedral with a large piazza, and is the civic center of Milan.

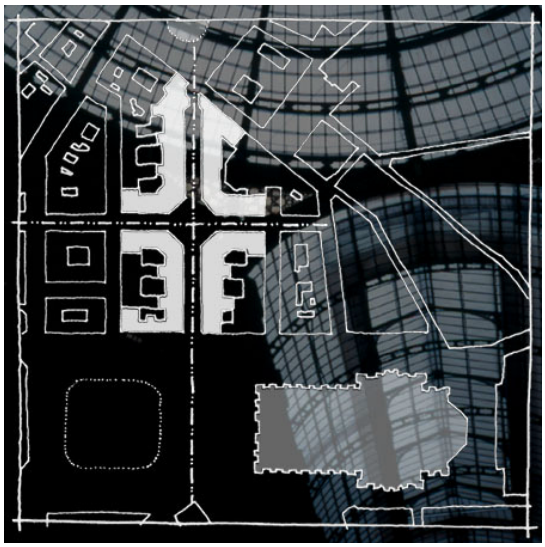


Figure 1: Plan and photograph of the Galleria Vittorio Emanuele II, Milan, Italy.

The Galleria consists of four main floors. The ground floor caters to the pedestrian, containing shops, showrooms, and cafes. Private offices are found on the second two floors, and residential apartments occupy the top floor.

The height from floor to top of vault is 110 feet, and the total length is over 600 feet. The only enclosure is the glass roof, and the ends of the arcade are open to the air. (Geist, 1983)

The Milan Galleria is the center of the city, the pedestrian arteries of Milan. With diverse functions, it is an effective, mixed-use facility. Owned privately, it acts as a public space, and amenity. The glass roof protects walkers in inclement weather, creating a novel indoor piazza. Through addressing these issues, the building stands as a success, an example for future designs.

Colonial & Cleveland Arcades, Cleveland, Ohio

The Colonial Arcade is a two-story passage connecting two 5-story office structures. The arcade is a straight corridor 400 feet long, but only 20 feet wide. The arcade was completed in 1898, and features a glass gambrel roof along its full length.

Figure 2: Plan and photgraph of the Colonial Arcade, Cleveland, Ohio, 1935. (Cleveland Public Library Photograph Collection)

The Cleveland Arcade is a three building complex that joins two 9-story office buildings with a 5-story arcade. The arcade was completed in 1891, the collaboration of an architect and structural engineer. At the time of construction, the roof trusses were revolutionary for their thinness; the arcade was featured in engineering journals around the world. (Schofield, 1966)

The Cleveland Arcade accommodates a 23-degree shift in axis, handled in a circular entry space. The arcade is the same length as the Colonial Arcade, but opens up to over 80 feet in width and 100 feet in height.

An elevation difference along the length of the arcade enables two ground floors of shops. The

Figure 3: Plan and photograph of the Cleveland Arcade. (Cleveland Public Library.)

upper three floors of the arcade originally housed

offices, galleries, and private studios, falling vacant in the 1970s. Both arcades are enclosed, glass doors at each end.

Within the last year, a private development corporation has purchased the two arcades, investing over 50 million dollars to restore their interiors. Upper floor offices have been converted into hotel rooms, and ground floor shops have been enlarged and updated.

The Colonial and Cleveland Arcades have the potential to anchor Cleveland's city center. The arcades can incorporate several mixed uses under one roof, bringing life to downtown. Owned by a private corporation, the arcades will again be part of a free, public pedestrian route. As enclosed walkways, the spaces will shelter during the winter, a thermal break from cold and winds.

Arcade and Transitional Space Research

Potvin makes a case for a greater diversity of thermal environments within the modern city, by the use of arcades through city blocks. He identified and evaluated the microclimate of 14 arcades in London and Cardiff using a head-mounted portable sensor array that measured wind speed, humidity, ambient and radiant temperature. Using the Penwarden thermal comfort equation based on wind speed, Potvin assessed thermal comfort of urban environments. (Potvin, 1999)

$$T_b - T_a = (M/A_{DU})R_b + k(M/A_{DU})R_c + (k(M/A_{DU}) + S)(4.2 + 13u^{0.5})^{-1}$$

T_b = Body core temperature = 37ºC
T_a = Air Temperature in ºC
M/A_{DU} = Metabolic rate of heat production per square meter of body surface W/m^2
k = Proportion of metabolic heat dissipated by means other than evaporation = 0.8
R_b = Thermal resistance of body tissues, m^2 deg C/W
R_c = Thermal resistance of clothing, m^2 deg C/W (1 clo = 0.155 m^2 deg C/W)
S = Solar heat input per square meter of body surface, W/ m^2
u = Wind Speed, m/ sec
$(4.2 + 13u^{0.5})^{-1}$ = Thermal resistance between clothing and surroundings, m^2 deg C/W

Penwarden's equations assume a body tissue resistance, R_b, between 0.04 m^2 deg C/W (onset of sweating) and 0.09 m^2 deg C/W (onset of shivering), and a metabolic rate of approximately 1.6 met, a subject walking at a moderate pace. (100 W/ m^2) (Penwarden, 1973)

In assessing thermal comfort of urban environments, Potvin quantifies the arcade as a hybrid form, categorized as between a building and a street. By serving as an intermediary, the arcade contributes to the overall thermal diversity of the city, allowing for greater variability between interior and exterior. Not limited to perform as a building, the arcade subsequently conserves energy.

The relevance of this research to future studies is in the application of a thermal comfort model as control. The Penwarden model, designed for exterior environments, is a standard applicable to all outdoor spaces. By assessing an arcade against this model, its role is defined in the context of the urban environment.

A variation on Potvin's method presents an opportunity for research. One approach would be to assess an arcade against a series of comfort models as a technique to determine an "appropriate" or relevant comfort model for arcades. Another method would be to compare historical concepts of comfort against seasonal data from arcades. This historical study would classify the role of the arcade in the evolution of comfort, expanding the written history of this building type.

A separate study could be to assess the arcade climatically, investigating only the arcades of a region. This type of study would shape the role of physical form and orientation in an arcade's performance, benefiting and enriching the design of future arcades.

Two questions posed by Potvin's research are especially relevant, and will frame this project:

- The application of Penwarden's model of thermal comfort is relevant for open-ended and free running arcades. *Would the same comfort model apply to conditioned and closed arcades,*

those typically found in the United States?

- The arcade is key to enabling thermal diversity and urban permeability in London and Cardiff. *Is there thermal diversity and urban permeability in the arcades in Northern America?*

Several studies in transitional space research have a relevance to arcades, summarized as follows:

Field measurements of thermal comfort were conducted at an airport and office building in Tokyo, Japan. The purpose was to create a model to predict the skin temperatures of both sedentary and transient subjects, in order to tailor spaces to their needs.

To accomplish this, measurements of ambient and radiant temperature, humidity, radiation, illuminance, and air velocity were assessed using a portable instrument cart. Data from the cart was used to create a simulation to demonstrate the thermal states of subjects within the spaces.

Each of the spaces was considered "transitional" because of large amount of people moving from outside to inside, and because each space acted as a thermal buffer for pedestrians. (Hayashi et al, 1986)

This experiment led to the conclusion that it is possible to create a numerical simulation to determine the thermal state of both a sedentary and walking person within a transitional space, and therefore to design a space to meet their needs. This model would be applicable to arcades, spaces that contain sedentary and transient subjects.

The value of this research is in the method of evaluating and measuring spaces.

- *What type of thermal comfort assessment device could be developed for an arcade?*
- *Would other measurements, such as thermal asymmetry and thermal stratification, make for a more complete analysis?*
- *Would a survey of pedestrian responses yield a greater accuracy?*

Another study, that of the half-opened space, or "hybrid" space, presents a method pertinent to investigate arcades. In this study, students walked along a set route through three spaces with set clothing values, casting votes on a thermal sensation scale. The experiment was repeated seasonally, with similar routes at the same time of day.

The experiment demonstrated how subjects are sensitive to an increase in temperature, and insensitive to a decrease in temperature. As seasons varied, there was a corresponding shift on a thermal sensation vote chart. (Chun & Tamura, 1996)

This project's relevance is in its documentation and presentation of the "human factor" of an arcade, the personal variables that affect thermal comfort. By surveying students along a set path, it is possible to get an objective analysis of thermal comfort, and votes on a sensation scale are tailored to specific points on a route.

- *How could a thermal sensation vote apply in researching arcades?*
- *What are common spaces and forms to all arcades, and do different thermal comfort zones apply to each individual and space?*

Thermal Comfort and Arcades

Designers often use ASHRAE 55-1992, *Thermal Environmental Conditions for Human Occupancy* (hereafter Standard 55) to design systems to provide an environment appropriate for thermal comfort. *Standard 55* defines a thermal comfort level deemed appropriate for all occupied indoor spaces.

Thermal comfort is expressed as the interaction of four environmental factors: air temperature, thermal radiation, air speed, and humidity; and two personal factors: activity (met) and clothing (clo). Standard 55 is based on the assumption that all occupants will be engaged in light, primarily sedentary activity in "typical" indoor clothing.

The only adaptation to seasonal variation is in a shift in the thermal comfort zone between winter and summer. This shift is an acceptance of individuals adapting their personal clothing values from season to season.

To account for activities outside primary, light sedentary activity, Standard 55 provides an equation to shift the thermal comfort zone. This equation would be applicable to arcades and transitional spaces, as pedestrians move at an elevated metabolic level (1.6 – 2 met) and varying levels of clothing depending on season.

T_o active = T_o sedentary – 3(1 + clo)(met – 1.2) (ºC)

T_o active = Active operative temperature
T_o sedentary = Sedentary operative temperature
clo = clothing insulative value (1 clo = 0.155 m^2 deg C/W)
met = metabolic rate (1 met = 58.2 W/ m^2)

This equation is appropriate between a metabolic rate of 1.2 and 3 met, and the minimum allowable operative temperature for all activities is 15ºC. (ASHRAE, 1992)

Potvin's method in investigating arcades was based upon the comparison of an arcade to exterior spaces, using an outdoor model of thermal comfort as control. The proposal of this project, in a similar vein, would be to utilize Standard 55 as a comparison tool to categorize arcades with interior environments. This approach would either evaluate an arcade against two other shopping types, such as an enclosed suburban mall and traditional shop, or weigh an arcades against similar interior forms: light wells and atria. This investigation would be limited by climactic region, as another control, investigating only the arcades of the Northwest United States.

To measure spaces, and compare thermal properties to Standard 55, a thermal assessment tool similar to those used in Hayashi et al. and Potvin's investigations would need to be assembled. At a minimum, the tool would need to quantify air temperature, radiation, air speed, and humidity, expanding to possibly include thermal asymmetry and stratification. The device would need to be portable, perhaps a "thermal backpack", powered from batteries, and constructed from available equipment to limit cost.

A final part to the investigation would follow the method of Chun and Tamura, using a thermal sensation vote to assess an arcade's performance. Student volunteers could visit the spaces seasonally, to get a variety of results, and this information could be compared to the data from field measurements.

Summary

To be a viable solution for the future city, the arcade must address the criticisms of its past. To research the arcade, there are several potential methods for evaluating these spaces, building from previous research methods. By better understanding arcades and transitional spaces, the designer can utilize accurate and appropriate solutions that conform to human needs and potentially save energy.

References

American Society of Heating, Refrigeration and Air Conditioning Engineers, 1992. ASHRAE 55-1992: Thermal Environmental Conditions for Human Occupancy. Atlanta: ASHRAE.

Blake, Peter. April, 2000. *A Street for All Seasons* in Architecture. New York: BPI Communications.

Chun C., and Tamura, A. 1996. *Thermal Environment and the Characteristics of Thermal Sensation Vote in Half Opened Spaces* in Indoor Air 1996, Proceedings of the 7th Annual Conference on Indoor Air Quality and Climate. Nagoya, Japan.

Geist, Johann Friedrich. 1983. *Arcades: The History of a Building Type.* Cambridge: MIT Press

Hayashi, T., Shibayama, A., Hasebe, R., et al. 1996. *Field Study on Thermal Comfort in Transient Spaces from Outdoor to Indoor* in Indoor Air 1996, Proceedings of the 7th Annual Conference on Indoor Air Quality and Climate. Nagoya, Japan.

Kostof, Spiro. 1995. *A History of Architecture.* New York: Oxford University Press.

MacKeith, Margaret. 1986. *The History and Conservation of Shopping Arcades.* London: Eastern Press.

Mumford, Lewis. 1961. *The City in History.* New York: Harcourt, Inc.

Penwarden, A.D.. 1973. *Acceptable Wind Speeds in Towns* in Building Science, vol. 8. London: Pergamon Press.

Potvin, Andre. 1999. *The Thermal Environment of 19th Century Arcades* in proceedings of the 30th Annual Conference of the Environmental Design Research Association. Edmond, OK: EDRA

Schofield, Mary-Peale. 1966. *The Cleveland Arcade* in Journal of the Society of Architectural Historians.

THERMAL COMFORT IN GREEK REVIVAL HOUSES IN TEXAS: A Computerized Energy Simulation

THERMAL COMFORT IN GREEK REVIVAL HOUSES IN TEXAS: A Computerized Energy Simulation

ANAT GEVA, Ph.D., Architect
Department of Architecture
Texas A&M University

ANAT GEVA, Ph.D., Architect
Department of Architecture
Texas A&M University

Introduction

The appeal of the Greek Revival style in America through the 19th century reflected the political spirit of the newly independent United States. It expressed the sentiment that America, with its democratic ideals, was a spiritual successor of ancient Greece. These strong feelings were evident not only in architecture, in naming of new towns, and in education, but were also part of the general culture of the period founded on classic myth, literature, and art. The archeological expeditions in Greece and their publications in American journals of antiquities (Hamlin 1964; Wiebenson 1969; Poppeliers et al. 1983; Kennedy 1989; Sutton 1992; Lane 1996) reinforced this cultural trend.

The Greek Revival style became one of the first in a succession of national styles that attempted to erase the regional boundaries previously marked by vernacular types. This attempt was reinforced by the many publications of popular carpentry/architectural books, such as, Lafever Minard's books (*Modern Builder's Guide,* 1833, and *The Beauties of Modern Architecture*, 1835) and Benjamin Asher's books (*The Practice of Architecture*, 1833, and *The Builder's Guide,* 1837). The pattern books guided builders how to build a Greek Revival house and revealed the aesthetics of this style in America. The books not only developed the domestic Greek Revival style, but also displayed a freedom in using the style's details.

The adaptation of the Greek temple front in United States houses during the 19th century usually employed a symmetrical white painted facade designed on the basis of one of the classical orders (i.e., Doric, Ionic, Corinthian) and included pediment gables, wide cornices with unadorned friezes, and horizontal transoms above entrances.[1]

However, since the interpretation of the recommended details was influenced by local political, economical, cultural and environmental conditions, the style was never, anywhere, 'pure'. As a result, the Parthenonic form lent its pediment front and portico to the architecture of the northern states, and its white columns and simplicity to the southern and western states (Kennedy 1989; Lane 1996). The style's plan and elevations were ideally suited to the traditional plan and gable-roofed houses in America. It became a logical continuation of the traditional Georgian style room layout in the northeast and of the simplified form of the dogtrot and early frame house in Texas. Very often the existing houses were modified to fit the style. A Greek colonnaded portico was added as an entrance, the windows were enlarged and symmetrical aligned, and the ceiling was heightened. Since the porch, the windows, and the high ceiling were already part of the traditional building pattern of Texas, built to accommodate the harsh summer conditions (Geva 1995a; 1995b), they were easily altered with Greek Revival details. (Hamlin 1964; Drury 1984; Sutton 1992).

While the literature acknowledges the Greek Revival style as a reflection of politics, socio-economic status, and fashion, the relationship of

[1] For additional review of the style see Hamlin (1964); Poppeliers et al (1983); McAlester (1991); Sutton (1992); Lane (1996).

this style and regional climatic conditions that determined the extent of comfort in these houses usually appears merely as an observational note that addresses the practical grounds of the style.

The objective of this paper is to fill the limited empirical basis offered by these observations and to examine how Greek Revival houses responded differently to regional climates. Specifically, the study posits that Greek Revival houses of the 19th century are more compatible with the hot-humid climate of southeast Texas than with the cooler climate of the northeast where this style originated.

In pursuing this objective the study analyzes two pairs of 19th century Greek Revival houses. Each pair consists of one house originally constructed in Texas and the other constructed in New York. The study tested the extent of the compatibility of the style with each specific climate utilizing a multi-method approach that incorporates two methods: a qualitative morphological analysis and a quantitative empirical methodology of computerized energy simulations.

The Sample Houses

The study analyzes two pairs of 19th century Greek Revival houses. Figure 1 shows the first pair of the Oliver Culver House (1818) built in Rochester, New York (top) and Matthew Cartwright House (1840) built in San Augustine, Texas (bottom). Figure 2 shows the second pair of Elihu Kirby house (1840) built in Henrietta, New York (top) and Governor Joseph D. Sayers House (1868) built in Bastrop, Texas (bottom).

Figures 1 and 2

The selection of the sample houses was based on the following four criteria:

(a) the houses within each pair are similar in their Greek Revival architectural features Similar Greek Revival architectural features both in plan and elevations.

(b) The construction period: 19th century when the style was originated and was popular all over the nation. In addition, this criterion eliminates buildings that were constructed with mechanical heating, ventilation, or electrical systems.

(c) The climatic regions: two of the houses are located in a cold region (up-state New York) and the other two are in a hot-humid region (east and south central Texas).

(d) Availability of Historic American Buildings Survey (HABS) drawings and pictures[2].

Procedure

The research proposition that the Greek Revival houses are more compatible with the hot-humid climate of Texas than with the cooler climate of New York is tested by two methods: a qualitative morphological analysis that evaluated the design of the houses along accepted architectural design guidelines for hot and cold climates; and a quantitative analysis in the form of computerized energy simulations. This proposition is formulated in the following two equations:

(1) For the houses of New York: $\mathbf{X_{(i)}V > X_{(i)}A}$

(2) For the houses of Texas: $\mathbf{X_{(i)}A > X_{(i)}V}$

The study tested each house in its actual site in Texas or New York (denoted as 'A' in the equations) and as if "transplanted" to the other location in Texas or New York -- the house's virtual (simulated) site (denoted as 'V'). The $X_{(i)}$ represents the two dependent variables in the study: $X_{(1)}$ the compatibility of the house with the regional morphological guidelines, and $X_{(2)}$ the energy performance of the house as calculated by the simulations.

Morphological Analysis of the Houses

Several design guidelines and architectural strategies were developed to accomplish thermal comfort in buildings constructed in different climate zones (Olgyay 1963; Brown 1985; Lechner 1991). These guidelines usually refer to site layout (i.e., orientation), building form and

[2] The analyses were performed only on the original 19th century houses.

geometry, construction and finish materials, and architectural details. Lechner (1991) suggests an explicit summary of the preferred conceptual design strategies for each climate zone. His design guidelines for the cold and hot-humid zones are used in this study.

The design guidelines for cold region (New York) include three major recommendations: keep the heat in, and cold temperatures out; protect the house from the cold winter winds which usually come from the West and Northwest; and use heavy masonry walls painted dark on the exterior to lengthen the time scale of heat transmission.

The design guidelines for hot-humid region (Texas) consist of three major recommendations: provide natural ventilation for cooling and removal of excess moisture; protect the house from sun and rain; and use lightweight construction materials (i.e., wood) painted white due to the small difference in temperature between night and day and to reflect the heat.

Each house of the study has been evaluated against the design recommendations for both climates using an ordinal ranking which seems appropriate for the qualitative nature of this analysis. A greater climatic comfort can be achieved in a house that fulfills most of the design strategies for the specific climate.

Figures 3 and 4 illustrate the floor plan of the two pairs respectively. All four houses are arranged around a main hall that opens to the rooms and to the front and back entrances. In addition, each room consists of maximum windows and doors for cross ventilation.

Figures 3 and 4

All four houses are wood frame buildings (lightweight materials) with white painted wood clapboard siding on the exterior walls. The bright paint reflects the sun.

All four buildings have horizontal and vertical transoms lighting at the entrance door, and rectangular windows with six lights in each of the double-hung sashes.

The Culver and Cartwright houses both are two story buildings with a small entry portico that does not extend the full height and width of the façade (see Figure 5). The porticoes include four or two Doric columns and have a front pediment. The houses are built with an end-low gable roof with wide trims.

Figures 5

The Kirby and Sayers houses are one-story buildings,[3] with an entry portico that extend the full height of the facade, but not the full width. (see Figure 6). The porticoes include four Doric columns and have a front pediment. These houses have a low hipped roof with wide bands of trim.

Figures 6

Table 1 and 2 summarize the extent of compatibility of each of the four houses with the design guidelines for cold climate (New York) and hot-humid climate (Texas), respectively. The buildings were rated as fulfilling a given criterion (√), partially fulfilling a specific criterion (0), or as failing to fulfill a given criterion (-). A greater climatic comfort can be achieved in a house that fulfills most of the design strategies for the specific climate.

Tables 1 and 2

As indicated before, all four houses were built with lightweight materials (wood) painted white on the exterior; low pitch gable or hipped roofs; covered porches and porticoes; and maximum windows and doors in each room for cross ventilation. These architectural features are consistent with the recommendations for

[3] The front facade of the Kirby house appears as one story, but actually includes an additional low-ceiling second floor

buildings in hot-humid climates. Moreover, these morphological features should be avoided in houses built in cold areas. As predicted in equation (1), the morphological compatibility of the houses of New York with the climate of the virtual location (Texas) is greater than their compatibility with the climate of their actual location (New York): $X_{(1)}V\{60\%, 70\%\} > X_{(1)}A\{11\%, 11\%\}$[4]. As predicted in equation (2), the morphological compatibility of the houses of Texas with the climate of their actual location (Texas) is greater than their compatibility with the climate of the virtual location (New York): $X_{(1)}A\{100\%, 80\%\} > X_{(1)}V\{22\%, 0\%\}$.

In summary, all four buildings fulfill or partially fulfill most of the criteria of the design guidelines for hot-humid climate, while they fail to fulfill (or partially fulfill) most of the recommendations for cold climate. These findings demonstrate that the Greek Revival design of these houses, regardless of their actual locations (New York or Texas), is more compatible with the hot-humid climate of Texas than with the cold weather of up state New York.

Computerized Energy Simulations

ENER-WIN -- a computerized energy simulation program is used in this study (Degelman and Soebarto 1994, 1995). This software enables to evaluate the comfort level of buildings with and without mechanical systems (HVAC), and lighting. The program performs an hour-by-hour energy simulation based on given climatic conditions, building description and economic data. This software includes a weather database, an envelope materials catalogue, and numerous user profiles based on ASHREA energy efficiency standards.

Two modes of the ENER-WIN program are used in this study. First the *passive system* which applies mainly to structures without HVAC. In this mode, the simulations evaluate the comfort level of the passively heated and cooled buildings. The output of these simulations represents the deviation of the internal conditions of the building from the designated comfort conditions. In other words, to assess the comfort or discomfort of these internal conditions, the simulation provides a summary of total operative temperatures expressed by Discomfort Degree Hours (DDH) (Al-Homoud's 1994). This output implies an inverse relation between the DDH and the compatibility of the building to the local climate.

The second run, the *active system* assesses the energy performance of a building with an HVAC system in energy units and dollars. This run can simulate historic buildings as if they include an HVAC system to indicate how much energy would have been required to achieve a designated thermal comfort in the buildings. Results of the active system simulations show the building's source energy in thousand Btus per square feet (kBtu/sq.ft.)[5] , energy loads in million Btus (MBtus)[6], and energy cost analysis[7] . The more Btus required to maintain thermal comfort, the less compatible the building is to the climate.

Two input files were prepared for each house of the study. One describes the house (the architectural envelope and details, and users' profile) in its original/actual location (i.e., New York or Texas). The second describes the same buildings, but changes the weather data. (e.g. weather data of the New York houses were changed to weather data of Texas, while the weather data of the Texas houses were replaced with weather data of New York). The simulations have been performed twice on each pair of houses using these input files. Utilizing

[4] The percentages in the parentheses express the extent of compatibility of each house with the specific climatic guidelines.

[5] Source Energy: energy consumed by the power plant to produce the total energy used by the building.

[6] The building's cooling/heating loads: how much energy is required to cool or heat the building

[7] Cost's results are not relevant for this study

the simulation program to "transplant" buildings from their actual location to a virtual (simulated) different location, enables to show the extent of climatic compatibility of the houses in different regions (Geva 1994; 1995a; 1997; 1998).

Figure 7 illustrates the findings of the passive system simulation runs. As predicted by equation (1) the houses of New York exhibit a higher comfort level (lower DDH scores) in the climate of the virtual location (Texas) than in the climate of their actual location (New York): $X_{(2)}V\{134,100; 150,400\} > X_{(2)}A\ \{242,100; 217,500\}$. In correspondence to equation (2) the houses of Texas are more comfortable (lower DDH scores) in the climate of their actual location (Texas) than in the climate of the virtual location (New York): $X_{(2)}A\{128,300; 112,600\} > > X_{(2)}V\{205,000; 217,600\}$. All four houses exhibit lower DDH scores in the hot-humid climate of Texas than in the cold climate of New York. Thus, these Greek Revival houses are more comfortable in Texas than in New York.

Figures 7

Detailed analysis of the simulations suggests that the major contribution to the higher numbers of DDH in New York is the discomfort associated with cold temperatures. Naturally, the discomfort due to hot temperatures is higher in Texas. However, the increase in the DDH due to the heat in Texas is smaller than the increase in DDH due to cold in New York. The results show that the Greek Revival houses better accommodate the hot humid than the cold weather conditions.

Figure 8 portrays the results of the active system simulation runs in kBtu/sq.ft In correspondence to equation (1) the energy performance of the houses of New York is better (lower kBtu/sq.ft.) in the virtual location (Texas) than in their actual location (New York): $X_{(2)}V\{47.9; 45.2\} > X_{(2)}A\{120.3; 133\}$. As predicted in equation (2) the energy performance of the houses of Texas (lower kBtu/sq.ft.) is better in their actual location (Texas) than in the virtual location (New York): $X_{(2)}A\{111.4; 142.1\} > X_{(2)}V\{279.3; 381.3\}$. These results corroborate the previous findings of DDH, and show that all four Greek Revival houses are more compatible with the hot-humid climate of Texas than with the cold climate of New York.

Figures 8

Detailed analysis of these simulations also show that the heating was the major contributor to the energy use of all four houses in all locations. The results show that even in Texas the heating load was larger than the cooling load. These findings reinforce the proposition that the Greek Revival style house better accommodates hot-humid conditions than cold climate.

Conclusion

The findings support the research proposition and introduce an additional angle to the study of nineteenth century Greek Revival houses in the south of the United States. It shows that in the south, this style represented not only the influences of politics, status symbols, and fashion, but also became a rational response to regional climate. Since most of the vernacular domestic Greek Revival houses were constructed from wood the study examined the wooden structures. These findings of this paper suggest an additional explanation of the popularity of this style in the south, and support the proposition that the construction of residences in the south was sensitive to local environmental conditions (see more on this proposition in Geva 1994, 1995a, 1995b and anecdotal evidence to that respect in Lane 1996:131). Further investigation should analyze masonry Greek Revival houses in addition to the wooden Greek Revival houses to understand their contribution to the study of the thermal comfort in Greek revival houses in Texas.

Finally, this study highlights two methodological implications. The utility of a multi-method approach to enhance the validity of

findings (Frankfort & Nachmias 1995). The rigor of computerized simulations provides quantitative means to test hypotheses and concepts of environmental theories in the context of history and place.

References

Al-Homoud, M. 1994. “Design optimization of energy conserving building envelopes” *Ph.D. dissertation*. College Station, TX: Texas A&M University.

Brown, G. Z. 1985. *Sun Wind and Light Architectural Design Strategies.* NY: John Wiley and Sons.

Degelman, L. Soebarto, V. 1994. “ENER-WIN: A visual interface model for hourly energy simulation in buildings,” Presented at *The E&R '94 Symposium* Prairie View: Prairie View University

Degelman, L. Soebarto, V. 1995. “Software Description for ENER-WIN: A Visual Interface Model For Hourly Energy Simulation in Buildings,” *Proceedings: Building Simulation '95*. *International Buildings Performance Simulation Association.* (August)

Drury , A. Webb, T. 1984. *Texas Homes of the Nineteenth Century,* 3rd ed. Austin, Texas: The University of Texas Press.

Frankfort -Nachmias, C. Nachmias D. 1995. *Research Methods in the Social Sciences,* 5th ed. New York: St. Martin's Press.

Geva, A. 1994."Computerized Energy Simulation: A Method for Testing Environmental Design Theory." *Proceedings of EDRA 94*

Geva, A. 1995a. "The Interaction of Climate, Culture, and Building Type on Built Form: A Computerized Simulation Study of Energy Performance of historic Buildings". *A Ph.D. Dissertation*. College Station, TX: Texas A&M University.

Geva, A. 1995b. "Whose Vernacular Architecture Is It? Vernacular Architecture of North European Immigrants in the US". Presented at the Annual Meeting of *the Society of Architectural Historians Southeast Chapter (SESAH)*), Birmingham, Alabama (November)

Geva, A. Soebarto, V. Degelman, L. 1997. "The Energy "Penalty" for Maintaining A National Image in Chain-Operated Buildings." *The ARCC (Architectural Research Centers Consortium) 1997 Spring Conference Book* .

Geva, A. 1998. “Energy Simulation of Historic Buildings: St. Louis Catholic Church, Castroville, Texas,” *APT Bulletin.* Vol. XXIX, No. 1

Hamlin, T. 1944 *Greek Revival Architecture in America*.. NY: Dover Publications(Reprint, 1964)

Kennedy, R.G. 1989. *Greek Revival America*. NY: Stewart, Tabori & Chang, Inc.

Lane, M. 1996. *Architecture of the Old South: Greek Revival and Romantic*. Savannah, Georgia: Beever Press.

Lechner, N. 1991. *Heating, Cooling, Lighting: Design Methods for Architects*. NY: John Wiley and Sons.

Olgyay, V. 1963. *Design with Climate* Princeton, NJ: Princeton University Press.

Poppeliers, J. Chambers Jr., A. Schwartz, N. 1983. *What STYLE Is It? A Guide to American Architecture.* Washington DC: The Preservation Press.

Sutton, R. 1992. *Americans Interpret the Parthenon: the progression of Greek revival architecture from the East Coast to Oregon, 1800- 1860.* Niwot, Co: University Press of Colorado.

Wiebenson, D. 1969. *Sources of Greek Revival Architecture.* University Park, PA: Pennsylvania State University Press.

Table 1. Summary of the Morphological Analysis for A Cold Region

Design guidelines	Specific criteria	**Culver house (NY)**	**Cartwright house (TX)**	**Kirby house (NY)**	**Sayers house (TX)**
Keep heat in, and cold out	orientation (S or SE)	–	√	–	–
	windows (minimum)	–	–	–	–
	windows (double glazing)	–	–	–	–
	compact design (two stories, basement)	√	0	√	–
Protect from cold winds	enclosed porches	–	–	–	–
	long sloping roofs	–	–	–	–
	tight construction	–	–	–	–
Construction materials	heavy masonry	–	–	–	–
	exterior walls pained dark	–	–	–	–

fulfill (√); partially fulfill (**0**); fail to fulfill (**-**)

Table 2. Summary of the Morphological Analysis for A Hot-Humid Region

Design guidelines	Specific criteria	**Culver house (NY)**	**Cartwright house (TX)**	**Kirby house (NY)**	**Sayers house (TX)**
Natural ventilation	orientation (S or SE)	–	√	–	–
	a crawl space under building	–	√	–	√
	windows, doors (maximum)	√	√	√	√
	ceiling (10' and higher)	–	0	0	√
	roof (low pitch gable or hipped)	√	√	√	√
Protect from sun and rain	plan (parts of building shade other parts)	–	√	–	√
	covered porches, porticoes	√	√	√	√
	shutters	0	√	√	–
	white color	√	√	√	√
Construction materials	lightweight materials (wood)	√	√	√	√

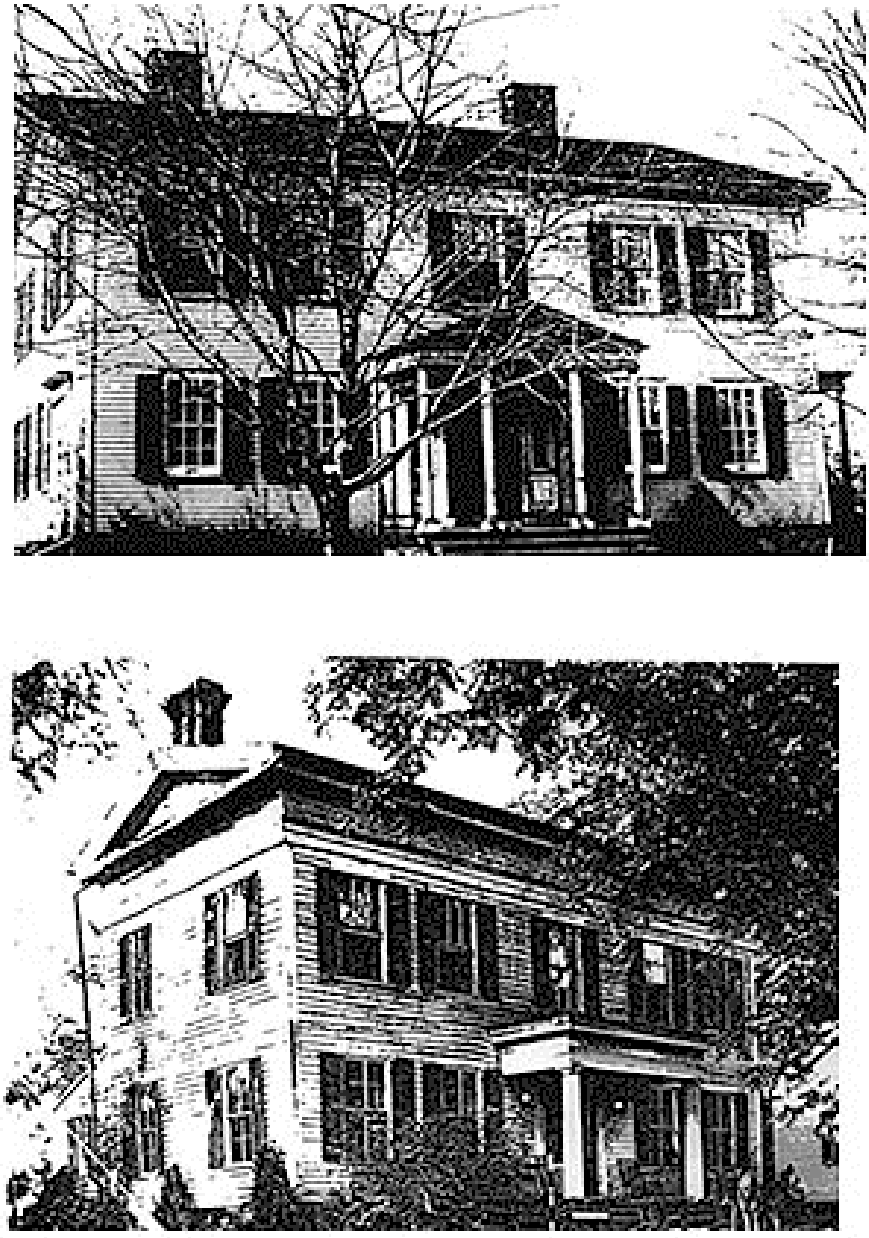


Figure 1. The Oliver Culver House, Rochester, New York (top)
The Matthew Cartwright House, San Augustine, Texas (bottom)

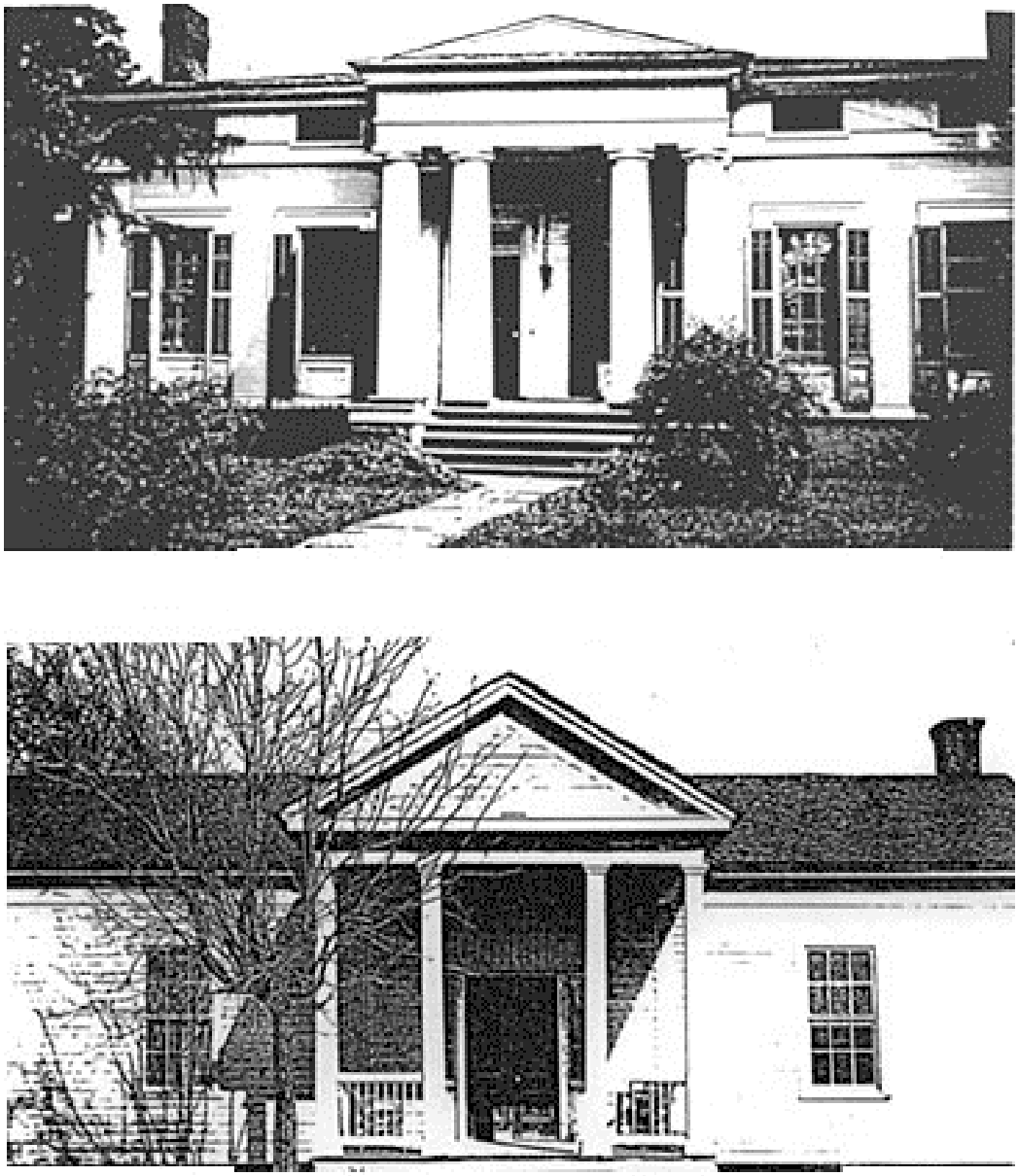


Figure 2. The Elihu Kirby House, Henrietta, New York (top)
Gov. Joseph D. Sayers House, Bastrop, Texas (bottom)

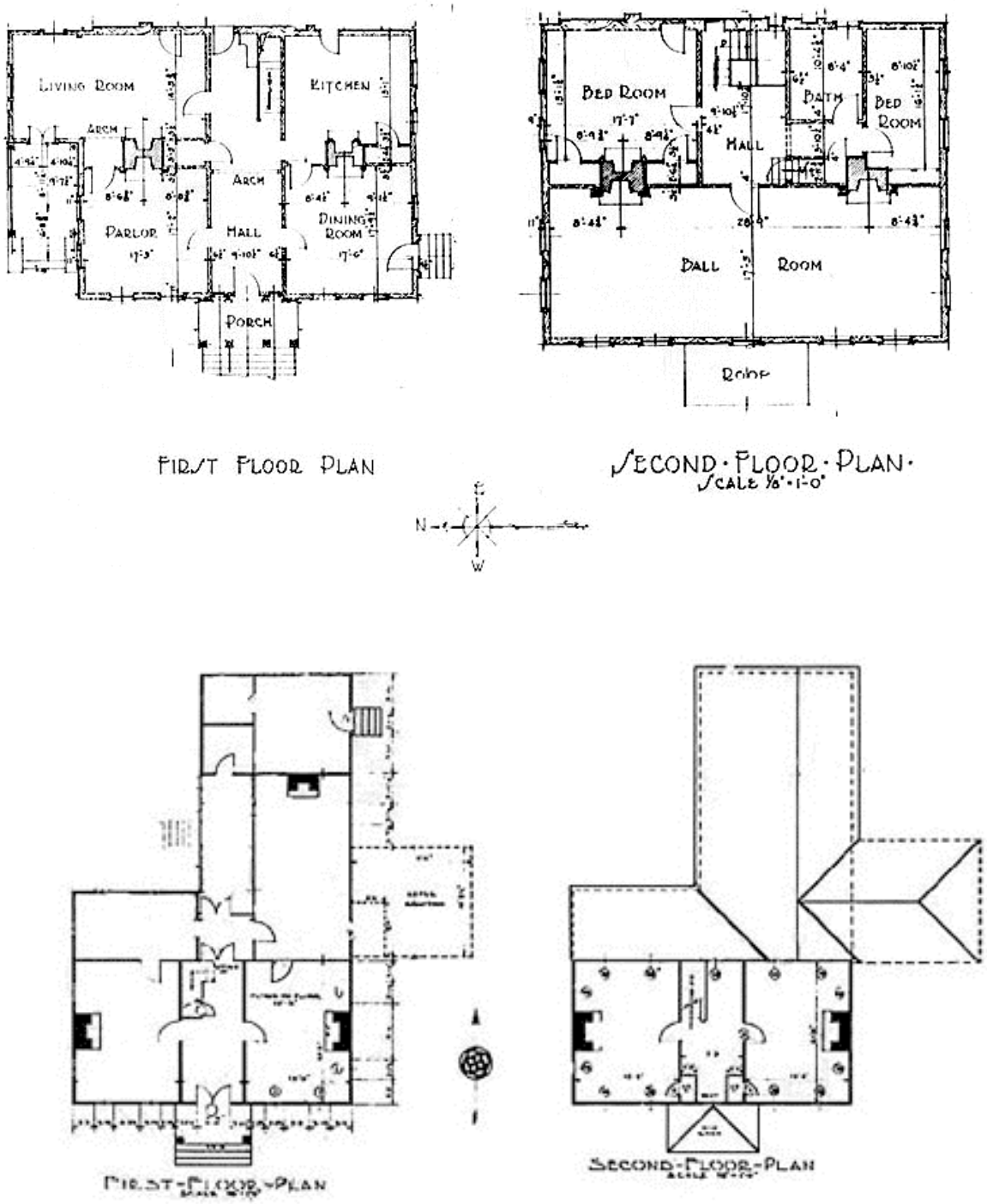


Figure 3. Floor Plan of Oliver Culver House, Rochester, New York (top)
and Matthew Cartwright House, San Augustine, Texas (bottom)

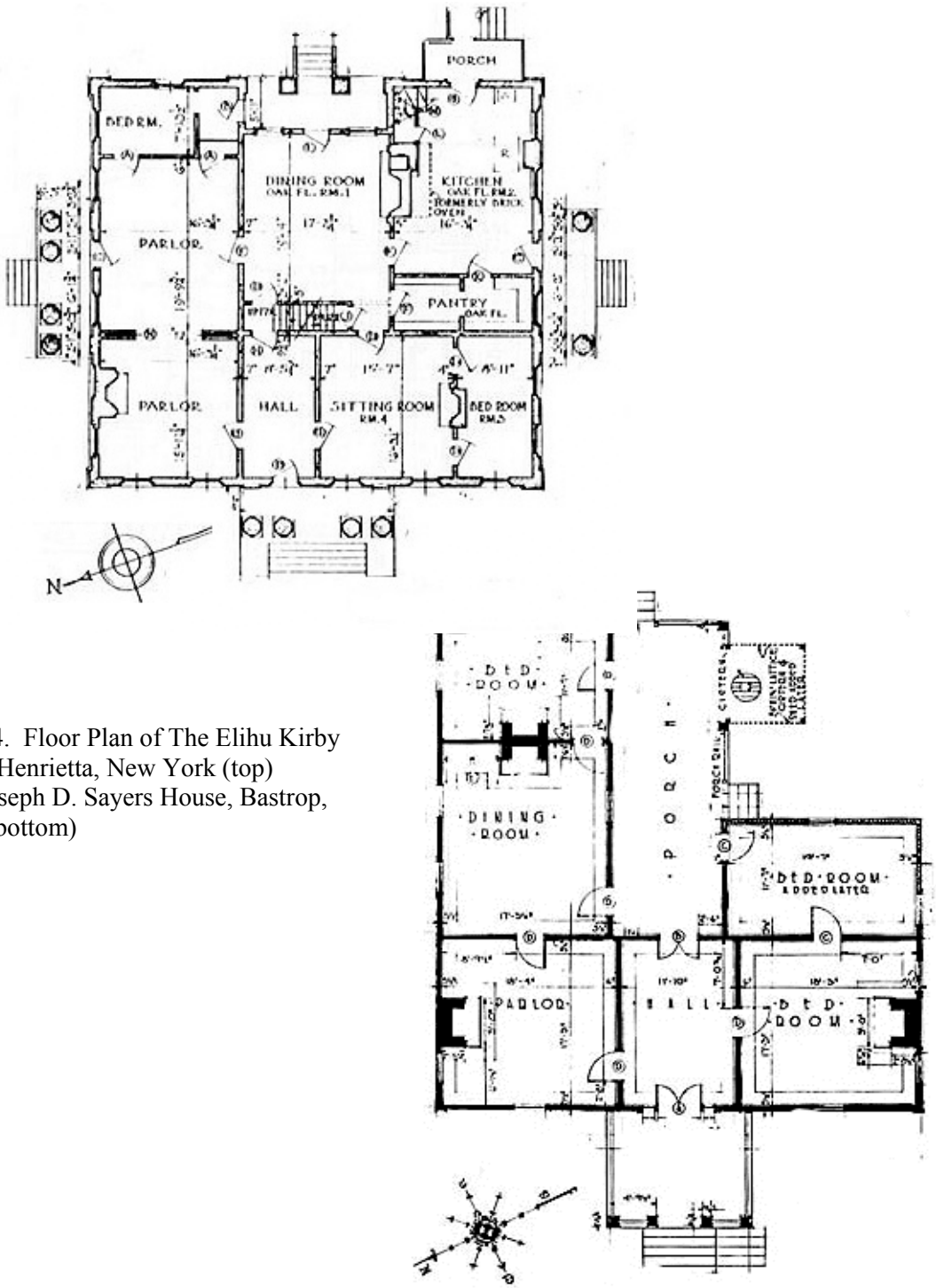
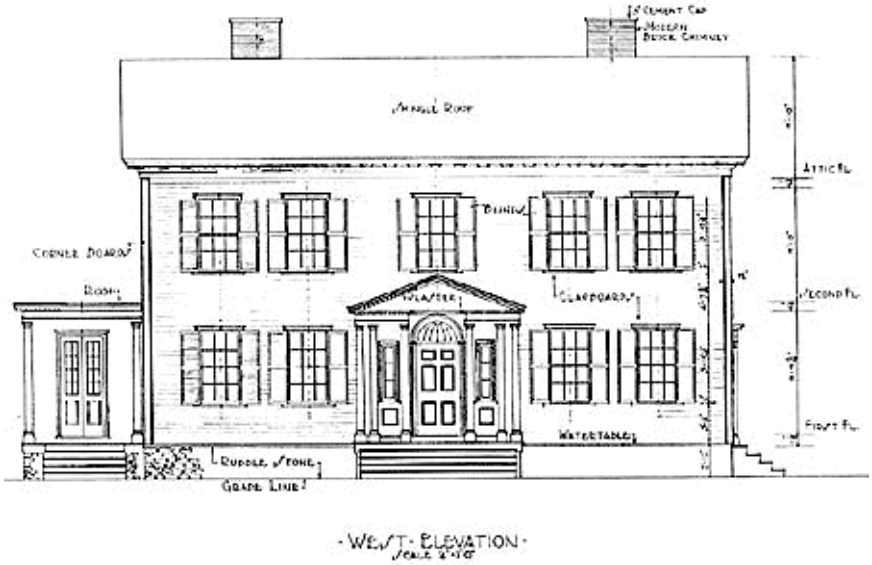


Figure 4. Floor Plan of The Elihu Kirby House, Henrietta, New York (top)
Gov. Joseph D. Sayers House, Bastrop, Texas (bottom)



WEST ELEVATION

FRONT (SOUTH) ELEVATION

Figure 5.
Front Elevation of Oliver Culver House, Rochester, New York (top)
and
Matthew Cartwright House, San Augustine, Texas (bottom)

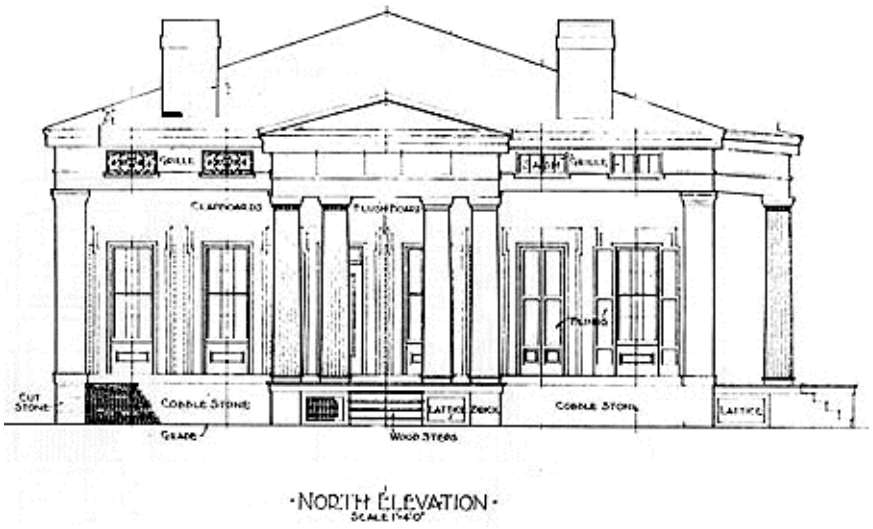


Figure 6. Front Elevation of The Elihu Kirby House, Henrietta, New York (top) The Gov. Joseph D. Sayers House, Bastrop, Texas (bottom)

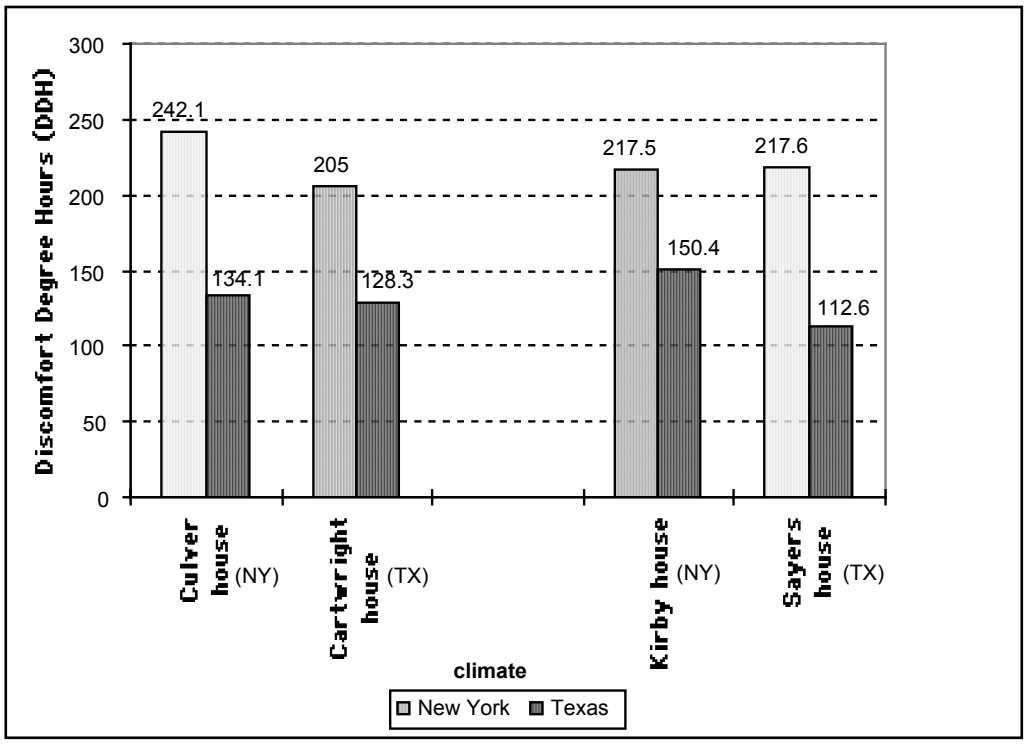


Figure 7. Results of the Passive System Simulation (DDH)

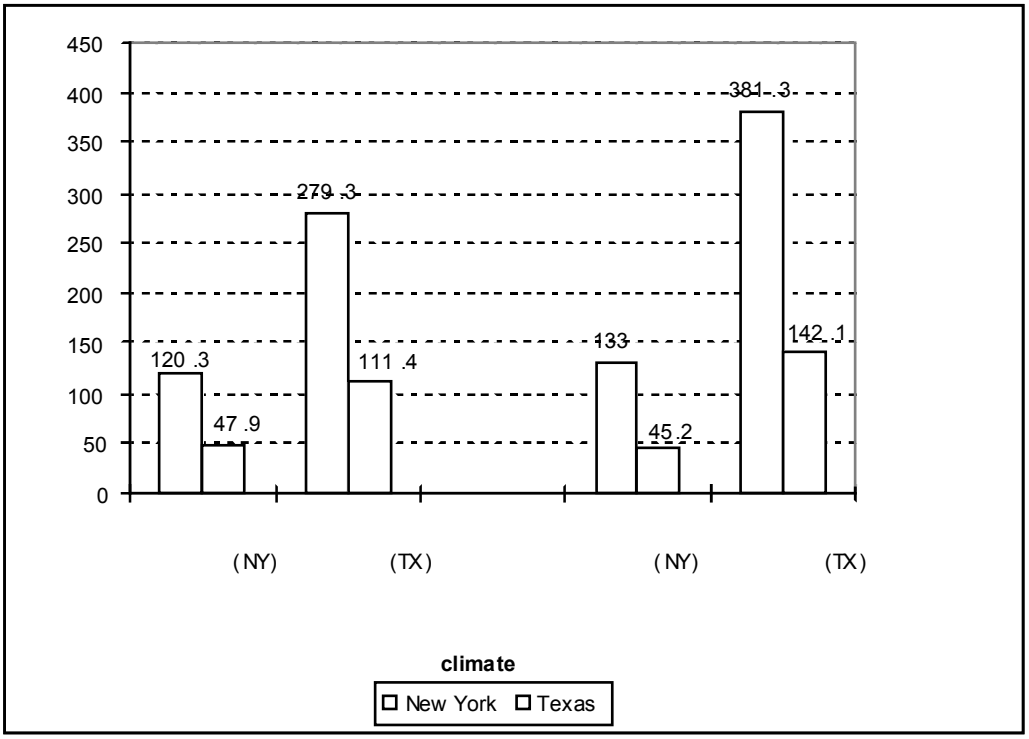


Figure 8. Results of the Active System Simulation (Source Energy in Kbtu/sq.ft.)

A Study of Preferences for Traditional and Modern Shopping Environments in Bangkok, Thailand: Preliminary Results

Apichoke Lekagul
Ph.D. Candidate, Environmental Design and Planning
Virginia Tech Email: alekagul@vt.edu

Patrick A. Miller, Ph.D., FASLA
Professor of Landscape Architecture
Virginia Tech Email: pmiller@vt.edu

Address: 208 Architecture Annex
Blacksburg, VA 24061
(540) 231-5506

Problem Statement

Traditional market shopping environments (see Figure 1) have long been an important part of Thai culture, meeting the economic, social, and psychological needs of Thai people. However, the introduction of western-style shopping environments, a result of the globalizing economy, has begun to change this. New, large-scale, commercial developments, especially shopping malls, are being developed primarily in modern-western styles, which have little relationship to native culture or traditions. The modern shopping environments have been successful economically. Traditional shopping environments are being replaced by westernized malls, resulting in a loss of cultural identity. Because of the size of these modern shopping malls and amount of land needed they require, they are typically developed along the city edge contributing to the problem of urban sprawl. In order to meet the needs of Thai shoppers, while at the same time preserving Thai culture and heritage, architects and planners must understand the preferences and attitudes of Thai shoppers toward different types of shopping environments. The purpose of this study is to identify attitudes and preferences of Thai shoppers toward shopping environments, both traditional markets as well as the newer westernized shopping centers.

Figure 1: An example of traditional outdoor markets

Method

The following research questions are posed: 1) Do Thai shoppers distinguish between modern and traditional shopping environments in making shopping decisions? 2) What are the physical characteristics of shopping environments that Thai shoppers prefer? 3) How do Thai shoppers differ in their preferences and attitudes based on age, shopping needs and habits, and other demographic characteristics?

This paper presents preliminary findings of an ongoing research. The purposes of this research are to; 1) identify environmental factors influencing the preferences of Thai shoppers related to their shopping needs and habits, and their demographic backgrounds; 2) provide guidelines for the development of new shopping environments that respond to the cultural tradition and heritage of the Thai people; 3) provide recommendations for modifying traditional shopping markets so they can better meet the needs of shoppers today so they will be more likely to survive in the new economy.

This research adopted Content Identifying Methodology (CIM) developed by Kaplan (1979). CIM utilizes shopper's preference ratings of different shopping environments, both modern and traditional, to identify underlying dimension of preferences (Kaplan 1979). In this research 51 color photographs were collected from various shopping environments in Bangkok Metro area and rated by 356 respondents using 1-5 Likert scale (1 = not preferred, 2 = preferred a little, 3 = preferred somewhat, 4 = preferred, 5 = very much preferred). In several public and residential settings in Bangkok, potential respondents, representing general Thai shoppers, were approached and asked if they would participate in a survey. In addition to preference ratings the survey consisted of questions on perceived shopping needs and habits, on demographic backgrounds of the participants and requesting free comment on selected scenes.

The preference scores were analyzed using factor analysis. Ratings of the 51 scenes were analyzed using maximum likelihood factor analysis with promax rotation. As Hair (1998) recommends, according to the size of the sample, scenes that loaded higher than .30 were considered significant and included in the analysis (Hair et al 1998). Five factors were extracted according to change in slope of the scree plot. Fifty percent of the total variances in preference were explained.

The factors are groups or sets of scenes called dimensions. The scenes grouped in a factor because they have a similar pattern of preferences. There is some visual stimulus that is causing viewers to react to the scenes in a similar way. The researchers examine the scenes in each dimension to identify stimuli that are common to each scene in the dimension.

Factor scores were used as dependent variables in multivariate analysis of variances (MANOVA) with categorical variables from shopping habit and demographic data as independent variables. The statistically significant (.05) results from multivariate test were follow-up tested on each dependent variable, and further post hoc testing was done using the Bonferonni method. All tests were conducted at .05 significance level.

Average means preference for the 5 dimensions were analyzed using ANOVA to compare preferences for the different environments. Content analysis was done on free comment data for selected scenes to help identify the environmental factors that were influencing people's reactions to the scenes in each dimension.

Results

The results indicate that whether a shopping environment is modern or traditional is a primary factor in people's reaction to the scene. Of the 5 dimensions, 2 are composed entirely of scenes that are traditional and 2 consist of scenes, which depict modern environments; with the fifth being the only dimension with scenes of both traditional and modern shopping environments. The traditional shopping environments grouped into two subtypes—*traditional outdoor markets*, and *traditional fresh markets.*

Modern shopping environments also grouped into two subtypes—*typical modern malls* and *modern malls with exposed products*. Both modern and traditional shopping environments grouped on the same dimension when they contained vegetation in relatively small outdoor spaces. This dimension was titled *outdoor markets with vegetation.*

Figure 2: An example of the most preferred dimension, typical modern malls.

Figure 5: An example of modern malls with exposed products, the fourth most preferred dimension.

Figure 3: An example of the second most preferred dimension, outdoor markets with vegetation.

Figure 6: The least preferred dimension, traditional outdoor market.

Figure 4: An example of the traditional fresh markets, tied for the second most preferred dimension.

Preference by Dimension:

ANOVA was used to test for significant differences in mean preference for the dimensions (see Table 1). Interestingly, the dimension with the highest mean preference for scenes contained in that dimension was the *typical modern mall* (see Figure 2) dimension (3.1). The second most preferred dimension was a tie with the *out door markets with vegetation* (see Figure 3) (2.9) and t*raditional fresh markets* (see Figure 4) (2.9). The fourth most preferred dimension was the *modern mall with exposed products* (See Figure 5) (2.8). The least preferred dimension was the *traditional outdoor market* (see Figure 6) (2.3*)*.

Table 1: Mean of preference scores of Thai shopping environment dimensions.

Rank	Dimension	Mean Preference
1	Typical modern malls	3.1
2	Outdoor markets with vegetation	2.9*
3	Traditional fresh markets	2.9*
4	Modern malls with exposed products	2.8
5	Traditional outdoor markets	2.3

All means are significantly different (ANOVA test at .05 level of significance) than all other means in lower rank order except those with an asterisk, which are not significantly different from the next lower order mean.

Factors Influencing Preference:

The content analysis of free response questions suggest three broad reasons for differences in preference: 1) the cleanliness and organization of space 2) the presence of vegetation and 3) opportunities for socialization and recreation. Each of these is discussed in more detail below.

The most frequent comments for scenes in the most preferred dimension, *typical modern malls*, were that the space was well-organized and spacious spaces with a clean, comfortable, and pleasant atmosphere. On the contrary, the less preferred *modern malls with exposed products* were referred to as poorly organized, tight and closed space. For traditional environments, the more preferred *fresh markets* were also referred to as well-organized and clean, while the less preferred *traditional outdoor markets* were mentioned as poorly-organized, dirty and dangerous.

The opportunities for social and recreation activities are represented by the appearances of the spaces that allow the possibility to wander around the shopping displays that provide opportunities to sit, rest, eat or drink and socialize. Scenes presenting these opportunities occurred most often in the most preferred *typical modern malls* in the form of central areas, seats, and cafés. Typical modern malls were also mentioned by the respondents as comfortable and that they want to be or sit there. These opportunities are also present in the second most preferred dimension *outdoor markets with vegetation.* The scenes in this dimension consisted of sitting areas and landscape. They were mentioned as shady, natural, pleasant, and having a sense of community. The presence of green vegetation or nature has been found to be an important factor in other environmental preference studies.

The results of this research are consistent with preference framework developed by Kaplan and Kaplan (1983). This framework suggests that content such as trees and nature have positive influence on preference and that places with a sense of mystery (spacious environments with the opportunity to move through and explore further) and high legibility (well organized easily understood places) are also preferred. A greater sense of mystery present in scenes in the *typical modern malls* dimension results in higher preference than scenes in *modern malls with exposed products*. Legibility is a factor in causing *fresh markets* to be more preferred than *traditional outdoor markets,* since *fresh markets* tend to be laid-out and displayed in a more-organized manner. People are able to make better cognitive maps of the market.

Shopping Behavior Variables:

Shopping behaviors play important roles in how people select places for shopping. They will select the places they perceived as suitable for their shopping needs. Analyses of preferences for shopping environments, using MANOVA, demonstrate significant differences among different group of shoppers for different shopping environments.

Shopping as a Social Activity:

The results of this research indicate, that in addition to meeting pragmatic needs for acquiring food and goods, that shopping is also a social activity. Family shopping habits, the number of people shopping together, time spent shopping, preferred time of day for shopping and the age and gender of the shoppers are all important factors in shopping environment preference.

Table 2: Relationships between environmental factors and shopping behavior and demographic backgrounds

Variables	Traditional outdoor markets	Traditional fresh markets	Typical modern malls	Modern malls with exposed products	Mixed outdoor markets with vegetation
Place decision			together than husband		together than wife
Shopping companion	family member, assistant, 1-2 friends	family member than 3+ friends	3 + friends	assistant	
Shopping time		Morning and noon	afternoon, evening		
Time spent					3+ than 1-2 hours
Age	51+	older	under 51		
Gender		female			male

Note: Significantly different categories under .05 level from post hoc tests were selected and reported in relation to the type of shopping environments

Family and Group Shopping Habits: Shoppers from families that all members decide the place to shop together significantly prefer *typical modern malls* and *outdoor markets with vegetation*. The families may need the places that offer them the most opportunities to sit, eat and socialize. Shoppers who go shopping with large groups of friends significantly prefer *typical modern malls*, which also offer the best possibility to relax and socialize. On the other hand, shoppers who go shopping with small groups of friends, a family member, or an assistant (a driver or a housekeeper) significantly prefer *traditional outdoor markets*, *traditional fresh markets*, and *modern malls with exposed products*. These shoppers may be looking for "economic value" more than social activity. Low and negotiable prices were frequent terms from the content analysis that were associated with traditional environments.

Time of Day: Shoppers who shop in the afternoon and evening significantly prefer *typical modern malls*, while shoppers who shop in the morning significantly prefer *traditional fresh markets*. People who shop in the morning are probably more interested in obtaining products at their freshest. Recreation or social shopping is probably more frequent later in the day.

Age group: Younger shoppers significantly prefer *typical modern malls* to other shopping environments. These younger shoppers may need more opportunity for social interaction in comfortable environment of *typical modern malls*. On the contrary, older shoppers seem to like traditional markets more than modern malls. The older shoppers may be used to traditional shopping environments and traditional ways of shopping such as negotiating price.

Time spent shopping: Shoppers who normally shop 3 hours or longer significantly prefer *outdoor markets with vegetation*. Since these shoppers spend longer time in the place, the opportunity to rest in shaded, sitting areas with vegetation would be important for them.

Gender: Female shoppers significantly prefer *traditional fresh markets*. Since women are often in the role of providing food for their families, fresh markets offer fresh products and foods, as also mentioned as having high quality by the respondents. Male shoppers significantly prefer *outdoor markets with vegetation*. Again, the opportunity to socialize may be more important to male shoppers.

Implication for the Future

The results of this research have implications for two aspects of design, planning and management of shopping environments: first, implications for the new shopping environments; and second, implications for enhancing existing traditional shopping environments. Each of these is discussed further below.

New Shopping Environments: New shopping environments should include those characteristics of the *modern malls* dimension, which was the most preferred dimension in the analysis. These characteristics include:

- A clean, well-organized appearance, including tidy product displays with well-defined and reasonably spacious circulation ways.
- Opportunities for resting and socializing, including benches, sitting areas and eating areas.
- Spatial arrangements that provide a sense of mystery – that is spacious arrangements of products and goods through which shoppers can move to explore and discover the goods and products being offered for sale.
- Vegetation to increase aesthetic quality and lower temperatures, particularly in outdoor environments.

In addition, as a means of preserving existing culture traditions new developments should experiment with including areas for more traditional style market stalls and venders within the new shopping environment. These could include fresh markets and specialty booths that could compliment stores commonly found in modern shopping environments. In addition to preserving Thai culture traditional style market areas could add color and a lively vitality to the more sterile modern shopping environment.

Enhancing Traditional Environments: The results of this research found that traditional shopping environments was the least preferred dimension. If traditional style Thai markets are to survive economically their appeal must be enhanced. This can be done in two ways: first, improve some of the existing negative characteristics that are commonly associated with traditional market environments, and second, by including features that will make them more responsive to a broader spectrum of Thai shoppers. Each of these is discussed in more detail below.

This research found that traditional Thai shopping environments are often perceived as being dirty, crowded and unsafe, making them unpleasant places for people to spend time. Traditional shopping environments need to be enhanced to make them more preferred and to attract a wider range of shoppers, thus preserve their viability. This can be achieved by:

- Enhancing maintenance to keep the environments clean.
- Increase the sense of security by adding lighting where necessary, reducing crowding and providing visible security measures (video cameras and security guards).
- Provide more order to the display areas and circulation system. When coupled with reduced crowding this will make the market more legible (people will have a better cognitive map of the market layout) and increase the sense of mystery (the ability to wonder through the displays and discover things).
- Preserve the existing preferred characteristics traditional markets, such as: fresh and specialty products, low and negotiable price, convenient location and access, and full interaction with products and sellers.

To attract a broader range of shoppers, traditional market environments need to include opportunities for rest and comfort, and increase opportunities for socialization. This can be done by:

- Provide trees and other vegetation to increase the aesthetic quality, as well as, provide shade and cooler temperature.
- Provide opportunities for resting, including benches and sitting areas.
- Provide opportunities for social interaction by including sitting areas, open restaurants and cafés, gathering spaces and public spaces for entertainment and cultural events.

An example of how these physical changes could be accomplished is included in Figure 7. The diagram depicts; a) the general layout of traditional markets; b) a first step improvement by adding vegetation, c) a second step improvement by widening secondary isles and adding sitting areas; and d) a third step improvement by adding gathering areas with landscape, including vegetation, sitting areas, and lawn. The improvements suggested not only increase aesthetic quality and opportunities for rest and social interaction, but also increase imagibility of the place in terms of nodes, landmarks, and districts (Lynch 1960).

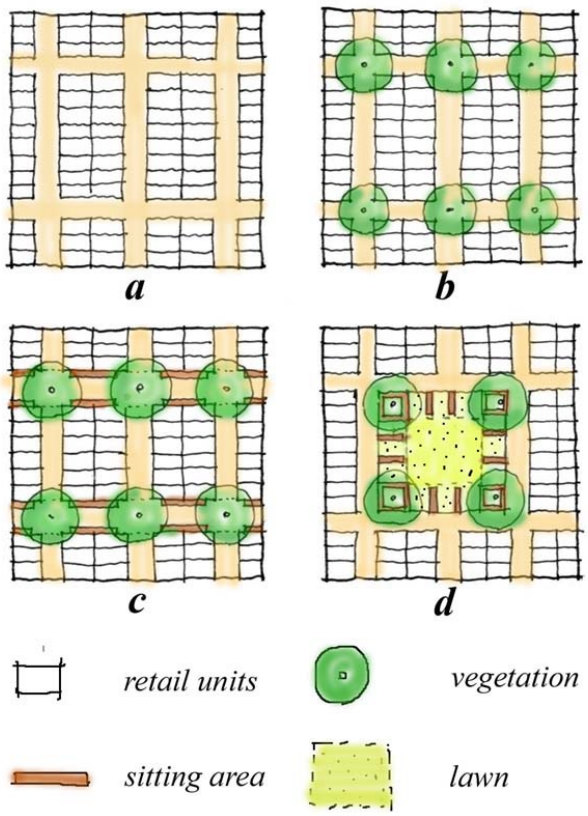


Figure 6: Graphic diagram of improvement for traditional environments

Conclusion:

The results of this research indicate that by identifying the preferences and perceptions of Thai shoppers it is indeed possible to preserve aspects of the traditional Thai market place, an important part of Thai culture and heritage. This can be done by incorporating aspects of the traditional Thai market in new shopping environments and by enhancing existing traditional markets to give them broader appeal and make then more viable in today's economy.

Bibliography

Hair, J; Anderson, R; Tatham, R; and Black, W. 1998. *Multivariate Data Analysis.* Upper Saddle River, New Jersey: Prentice Hall.

Kaplan, S. 1979. "Concerning the Power of Content-Identifying Methodologies", in *United States Department of Agriculture, Forest Service General Technical Report RM-68: Assessing Amenity Resource Values*. Daniel, T. C., Zube, E. H., and Driver, B. L. eds. Fort Collins, Colorado: Rocky Mountain Forest and Range and Range Experiment Station

Kaplan, S. and Kaplan, R. 1983. *Cognition and Environment: Functioning in an Uncertain World*. Ann Arbor, Michigan: Ulrich's Bookstore

Lynch, K. 1960. *The Image of the City*. Cambridge: MIT Press.

Applying a Constructivist Pedagogy to Design Studio Education

By Matt Powers, Virginia Tech

Introduction

This paper will apply a constructivist philosophical framework to teaching and learning in the landscape architecture studio. First, the paper provides some meanings associated with constructivism followed by the changes in the worldview that affected constructivism. The paper next discusses constructivism in education and defines two variations of it, radical constructivism and social constructivism. Finally, 10 pedagogical principals suggested by constructivists are listed and related to the design studio.

The main goal of this paper is to help in the reassessment and redesign of the construction process inherent in teachers, learners, and the studio system. Often, actions of educators are not necessarily guided by an overt knowledge of the reasoning behind these actions. Intuition, successful experiences, and observations: these factors play an important role in influencing the behavior of teachers and, no doubt, often dictate their practice (Murphy 1997). Educators often adopt and utilize a particular approach or method without necessarily having purposely considered the theory or philosophy that underpins it. This paper is important because it helps to guide the development of a philosophical framework unconsciously employed by many design teachers already. This paper reiterates von Glaserfeld's (1995) comments: "constructivism does not claim to have made earth-shaking inventions in the area of education; it merely claims to provide a solid conceptual basis for some of the things that, until now, inspired teachers had to do without theoretical foundation" (p. 3).

Shifting Epistemologies and Constructivism

Knowledge, its nature and how we come to know, are essential considerations for constructivists. Beliefs about knowledge, inform, justify, and sustain our practices of education. (Gergen 1995). If we believe that learners gain knowledge by passive reception of information then priority in instruction will be on knowledge transmission. However, if we believe that learners actively construct knowledge in their attempts to make sense of their world, then learning will likely emphasize the development of meaning and understanding (Murphy 1997).

Early theories emphasized knowledge acquisition as the awareness of objects that exist independent of any subject. According to this objectivist view, objects have intrinsic meaning, and knowledge is a reflection of a correspondence to reality. In other words, knowledge represents a real world that is thought of as existing, separate and independent of the knower; and this knowledge should be considered true only if it correctly reflects the independent world. Beliefs such as passive transmission of knowledge continue to dominate most pedagogy today in the form of direct lecturing, memorization, and passive learning activities.

However, constructivists prefer to reject the idealized view of truth inherited from the ancients and modernists by replacing it with a dynamic, changing truth bounded by time, space, and perspective (Wilson 1997). The educational constructivist view argues that knowledge and reality does not have an object or absolute value, at the least, we have no way of knowing this reality. Von Glasersfeld (1995) indicates the concept of reality as "made up of the network of things and relationships that we rely on in our living, and on which, we believe, others rely on too" (p. 7). The knower interprets and constructs a reality based on his experiences and interactions with his environment. Constructivists generally claim that knowledge is not discovered but actively made and the ideas teachers teach do not correspond to an objective reality.

The next two sections will focus on radical and social constructivism. It is important to note that within education, constructivism has several theoretical forms but this paper will focus on radical and social constructivism because of their more widespread acceptance and applicability.

Radical Constructivism

Radical constructivism maintains that within the growth of knowledge, making is more important than finding. The idea of making as relating to a

subjective construction while the notion of finding can be akin to an objective revelation. Ernst von Glasersfeld, a leading proponent of radical constructivism, suggests "to know" actually should be understood "to know how to make" (Von Glasersfeld 1989). Von Glasersfeld continues by writing that the human knower, unlike God, can know only that which the human knower has constructed or made. Radical constructivists oppose the idea of a completely external world and reality separate from the human knower. Radical constructivism replaces this observer-independent model of knowledge with the idea that knowledge is comprised of conceptual structures created by individuals in a fashion congruent with their experience and perspective.

Jean Piaget, a psychologist and contributor to radical constructivist ideology, provides one explanation for the construction of knowledge. Piaget's central thesis holds that knowledge is built through human change and adaptation and will survive in so long as that knowledge remains useful. Further, adaptation, similar to its evolutionary meaning, refers to the ability of an individual to create coherent conceptual frameworks of the world as it is experienced and sustain these frameworks until they are no longer viable (von Glasersfeld 1995). Adaptation directly refers to change. Change through adaptation, according to radical constructivists, is how we begin to build knowledge. Knowledge is then maintained or disregarded through the process of adaptation as new and old concepts loose their poignancy or viability. In this sense, an idea that doesn't seem to "fit" into an individual's ontology will loose its viability. This causes the individual to adapt to this change and set in motion the creation of new knowledge. To the constructivist, viability, which is changeable, replaces universal truths, which are static.

An example of radical constructivist ideology in the design studio is seen in the methods for evaluating student work. There is almost certainly no absolute right or true way to evaluate student work independent from the individuals involved in the evaluation. In other words, no standardized or normalized method of evaluation can exist because it could not be applicable in all situations for all times. Instead, teachers evaluate student work using a method that seems viable to them given the particular goals and context of the students and work being evaluated. This method may, for example, tend to be qualitative or quantitative depending on a variety of factors the teacher has considered important. The teacher utilizes their adopted evaluative method until it does not seem viable or effective any longer. At this point, the need to adapt should force the teacher to construct a new method for evaluating student work based upon their particular perspective of the current situation.

Social Constructivism

Social constructivism encompasses a variety of views. Some views claim knowledge is the product of our social practices and institutions. While others views stress social interactions and negotiations between relevant social groups. Defenders of social constructivism insist that the world is accessible to us only through our shared interpretations, and the idea of an independent reality is at best an irrelevant abstraction and at worst incoherent. (Gasper 1999, p. 855). Social constructivism differs vastly from radical constructivism in general epistemology and ontology. For example, radical constructivism holds that knowledge is subjectively created through personal experiences within the context of the individual. In contrast, social constructivism holds that knowledge is created and determined viable through functional and pragmatic social interaction. Social constructivism sees consensus between different subjects as the ultimate criterion to judge knowledge. "'Truth' or 'reality' will be accorded only to those constructions on which people of a social group agree" (Heylighen 1993, p. 2)

Social constructivists see language as a key to understanding reality since meaning of the world is linked to specific meanings of words shared by groups of people. Language provides the shared structure necessary for communicating meaningful ideas and thoughts. Since meaning is derived from language and language is interdependent between two or more persons, it follows that socio-cultural processes of negotiation, cooperation, conflict,

rhetoric, ritual, roles, social scenarios, and the like are crucial factors in the development of meaning and reality.

An example of social constructivist ideology in the design studio can again be shown in relationship to the methods for evaluating student work. A method of evaluation is effective and useful if it is determined to be so by a particular group. This group may be students, teachers, professional organizations, or any other interactive culture or group. The group prescribes and utilizes an agreed upon evaluative method until it is held by the group as unusable or ineffective. At this point, the need to adapt should force the group to construct a new method for evaluating student work based upon their collective perspective of the current situation.

Educational Constructivism's Combined Learning Principals

The process in which knowledge is conceived and acquired, the types of knowledge, skills and activities emphasized, the role of learner and teacher, how goals are established: all of these factors are articulated differently within the various constructivist perspectives (Murphy 1997). These differences amongst constructivists, do however, provide an increased diversity and applicability to studio education when synthesized.

The following sections will provide 7 principals for applying constructivist ideology to the design studio. With each principal, an example of how the principal can be applied to studio is given. The 7 principals are based upon the work of many radical and social constructivist authors in conjunction with the experience of the author as both student and teacher. Most of the principals have recently proved fruitful in studio trials while a few are in need of corroboration. Regardless, the 7 principals represent a challenge to current pedagogy and will provide needed discourse.

The following authors were utilized in the creation of the 7 principals: Borich and Tombari (1997), Brooks and Brooks (1993), Driscoll (1994), Driver, Aasoko, Leach, Mortimer, and Scott (1994), Eggen and Kauchak (1997), Gergen (1995), Honebein (1996), Jonassen (1991), Lee (1999), Mitchell (1989), Savery And Duffy (1995), Stanbridge (1990), von Glasersfeld (1996), Wagner and McCombs (1995), Wilson (1995), Wilson and Cole (1991), Zimmerman (1989).

1) Establish Prior Constructions of Knowledge.

Constructivism suggests that any form of learning should be personally relevant to the learner. Providing relevant situations helps students to perceive learning as purposive and not view the task as merely an assignment to be undertaken. For a constructivist, the determination of relevance comes from assessing the learner's previous knowledge constructions, beliefs and attitudes. Acknowledging the importance of prior learning also helps teachers understand their student's points of view and conceptions so that new ideas can be taught in the context of current understandings. Prior knowledge is the initial building blocks from which teacher and learner must begin construction. For example, a studio instructor could establish prior constructions of student knowledge by talking to the student's previous teacher or interviewing the students.

2) Formative Assessment and Evaluation

Assessment should be authentic and interwoven with teaching. Assessing a learner's knowledge acquisition during the lesson provides a glimpse into the construction process a particular student employs. The pursuit of student questions is highly valued as a method of assessing and helping diagnose the student's process for structuring problems. However, assessment should not be reserved for the student alone. Periodic assessment should also serve as a self-analysis tool for the teacher because teachers knowledge, like students, is open to construction and reconstruction (von Glasersfeld 1996). A teacher's current knowledge and beliefs are expressed in the way they plan, design, teach, make decisions, and evaluate their studio and students. Problems or surprises encountered within the studio provide opportunities for reorganization of knowledge and beliefs. For a constructivist, assessment is used to elicit and describe the student's construction processes with the notion that understanding processing will allow for successful intervention and advancement of knowledge construction. One example of using

formative assessment within the studio is having students assess each other during pin-ups by answering certain focused questions on note cards and then returning them for review.

3) Students Negotiate Goals

Goals and objectives should be derived by the student or in negotiation with the teacher and studio. Providing an environment that encourages social negotiation as an integral part of learning will accustom students to using thoughtful discourse and other means of negotiation for achieving their needs. For a constructivist, students must be able to plan and set their own goals, reflect and assess their progress as well as determine how to proceed. If students are to be expected work with all their intellect and emotion then it is important that they be empowered. Empowering students however needs to be complemented by self-regulation. In the studio, a teacher could allow students to propose the product they will submit for a particular project based upon their starting level of understanding. Students and teacher could also negotiate deadlines with respect to what they propose to produce.

4) Create Authentic Problems

In the constructivist studio there is provision for ambiguity and uncertainty. Again, the embedding of learning within relevant contexts is important. The studio should create learning situations, environments, skills, content and tasks that are realistic, authentic, and represent the natural complexities of the 'real world'. A means to providing personal relevance is by simulating authentic problems without lowering the degree of cognitive complexity. Since these problems are similar to the challenges students will face in their real world, tasks requiring problem solving become more engaging, as the students want to know what the possible outcomes may be. For example, a studio teacher may use juries composed of people outside design to review projects and submit comments that are similar to those a potential client group may provide.

5) Emphasize Big Concepts and Interconnectedness

For a constructivist, problem-solving, higher-order thinking skills and deep understanding are emphasized. Knowledge complexity is reflected in an emphasis on conceptual inter-relatedness and interdisciplinary learning. By placing emphasis on big concepts the learner does not focus on details that tend to change more rapidly than the structures upon which they rest. In a studio, the teacher may choose to focus on a bigger concept such as graphic representation rather than focusing on a particular method for rendering plans.

6) Encourage Multiple Representations

For a constructivist, multiple representations of concepts and content are presented and encouraged. However, the overriding importance is on knowledge construction and not merely representation, particularly if presented as the sole final reflection of the 'real world.' Providing access to multiple modes of representation such as a numerous example work helps to stress conceptual inter-relatedness and multiplicity. The notion that the world is getting smaller and more multicultural suggests that teachers provide tools and environments to help learners interpret and appreciate multiple perspectives of the world. According to constructivists, not only should the teacher provide multiple representations but also learners need to have the opportunity to present their work and ideas in a variety of ways. In the studio, teacher and learners should utilize constructive discourse consisting of verbal, written, and graphic languages. A studio teacher might, for example, using video or role playing to both present case studies.

7) Errors are Opportunities

In a constructivist studio, errors provide the opportunity for insight into students' previous knowledge construction. The use of errors as a mechanism to provide feedback on learners' understanding is a key component to constructivism. Desk critiques and pin ups of in-progress work will expose many ill-structured constructions to the

teacher and other learners. Allowing students to find problems in their own work and the work of others exposes different perspectives and processes. To a constructivist, process takes precedent over product because a truly final thing-in-itself can never be achieved. Therefore no error is final and confusion can always be cleared if the teacher and learners take the time and effort to examine their constructions.

Teacher and Learner Roles

In von Glasersfeld's (1995) conception of learning, the teacher plays the role of "midwife in the birth of understanding" as opposed to "mechanics of knowledge transfer". Teacher's roles are not dispensing of knowledge but to provide students with opportunities and incentives to build it up. To a constructivist, teachers serve in the role of guides, monitors, coaches, tutors, and facilitators and essentially teach learners how to learn. In a constructivist system, emphasis shifts from teachers' problem solving power alone to teachers and students joint fallibility and problem solving potential. Constructivist teachers view learning as a joint cognitive venture and encourage ownership and voice in the learning process.

To a constructivist, students are viewed as thinkers with emerging views and theories of the world. The student plays a central role in mediating and controlling learning. Therefore students should assume responsibility for their own learning and take measures to achieve its success. Teachers need to trust students to solve problems and students need to trust teachers to respect their efforts. Students need to depend on a teacher, and other students, to be supportive of their ideas, rather than to react disparagingly to seemingly incorrect views. Students desire to trust a teacher to deal eventually with most issues of concern, and students need to believe that confusion or unease is temporary only, as construction can take time and resolution will occur eventually. In a studio, for example, students should be shown how to assess their own designs and then allowed the opportunity to act accordingly.

Implications for Studio Pedagogy

Constructivism implies that teachers and learners within the studio are busily constructing knowledge and the recognition of their constructions can lead to positive intervention in the process resulting in the advancement of effective and efficient growth. Responsibility in the learning process should be shared and negotiated amongst teachers and learners. An enriched studio environment with a multiplicity of informational sources and representations will help students and teachers reflect upon their prior knowledge. The studio is an excellent place for the outgrowth of constructivism. The nature of design with its uncertainty and irregularities are congruent with the epistemology and ontology of constructivist pedagogy. The inclusion of constructivist ideology within current curriculums and studio courses will help add theoretical credibility to existing studio teaching practices and most importantly increase learning and advance constructions of knowledge.

References:

Agnes, M., Editor. 1999. *Webster's New World College Dictionary*. Second Edition. New York: Macmillian USA.

Borich, G. and M. Tombari. 1997. *Educational Psychology*. New York: Longman.

Brooks, J. and M. Brooks. 1993. *The Case for Constructivist Classrooms.* Alexandria, VA: ASCD.

Driscoll, M. 1994. *Psychology of Learning for Instruction.* Boston: Allyn and Bacon.

Driver, R., H. Aasoko, J. Leach, E. Mortimer, and P. Scott. 1994. "Constructing Scientific Knowledge in the Classroom." *Educational Researcher* 23(7): 5-12.

Eggen, P. and D. Kauchak. 1997. *Educational Psychology: Windows on Classrooms.* Upper Saddle River, NJ: Prentice Hall.

Gasper, P. 1999. "Definitions of Constructivism." *In Cambridge Dictionary of Philosophy*. Second Edition. Robert Audi, Editor. Cambridge, UK: Cambridge University Press. Pg.855.

Gergen, K. J. 1995. "Social Construction and the Education Process." In *Constructivism in Education*. Steffe, L. and J. Gale, Editors. Hillsdale, New Jersey: Erlbaum Associates, Publishers.

Heylighen, F. 1993. Epistemology, Introduction. *Principia Cybernetica*. Available at: http://pespmcl.vub.ac.be/EPISTMI.html

Honebein, P. 1996. "Seven Goals for the Design of Constructivist Learning Environments." (pp. 17-24). In *Constructivist Learning Environments*. Wilson, B., Editor. New Jersey: Educational Technology Publications.

Jonassen, D.H. 1991. "Objectivism Versus Constructivism: Do We Need a New Philosphical Paradigm?" *Educational Theory, Research &D*esign 39(3): 11-12.

Lee, C. S. 1999. "Problem-solving in a Constructivist Environment." Educational Technology and Society 2(4).

Mitchell, I. 1989. "The Influence of Class Dynamics on Individual Learning." *Research in Science Education*. 19: 198-209.

Murphy, E. 1997. "Constructivism: From Theory to Practice." Available at: http://www.stemnet.nf.ca/~elmurphy/emurphy/cle.html.

Savery, J. R. and T. M. Duffy. 1995. "Problem Based Learning: An Instructional Model and its Constructivists Framework." *Educational Technology* 35(2): 32-35.

Shotter, J. 1995. "In Dialogue: Social Constructivism and Radical Constructivism." In *Constructivism in Education*. Steffe, L. P. and J. Gale, Editors. Hillsdale, New Jersey: Erlbaum Associates, Publishers.

Stanbridge, B. 1990. "A Constructivist Model of Learning Used in Teaching of Junior Science." *Australian Science Teachers Journal* 36(4): 20-28.

Wagner, E. D. and B. L. McCombs. 1995. "Learner-centered Psychological Principals in Practice: Designs for Distance Education. *Educational Technology* 35(2): 32-35.

Wilson, B. and P. Cole. 1991. " A Review of Cognitive Teaching Models." *Educational Technology Research and Development* 39(4): 47-64.

Wilson, B. 1995. "Metaphors for Instruction: Why We Talk About Learning Environments." *Educational Technology* 35(2): 25-30.

von Glasersfeld, E. 1989. "Cognition, Construction of Knowledge, and Teaching." *Synthese* 80: 121-140.

von Glasersfeld, E. 1995. "A Constructivist Approach to Teaching." (pp. 3-16). In *Constructivism in Education*. L. Steffe and J. Gale, Editors. Hillsdale, New Jersey: Erlbaum Associates, Publishers.

von Glasersfeld, E. 1996. "Introduction: Aspects of Constructivism." (pp. 3-7). In *Constructivism: Theory, Perspectives,and Practice*. C. Fosnot, Editor. New York: Teachers College Press.

Zimmerman, B. 1989. A Social Cognitive View of Self-regulated Academic Learning." *Journal of Educational Psychology* 81: 329-33.

Towards a Paperless Studio

Frederick Norman: Ball State University

The infusion of digital media into the practice of architecture is changing how we design as well as what we design. Digital media has altered the process of design and the culture of design education. The question before us is how does one transition from a completely analog system of representation to one of complete computer immersion or the "paperless studio". Schools of Architecture have already begun to struggle with the physical issues of integration of new media (infrastructure and economics). But the pedagogical integration of new media should be of a greater concern. New media and its forms of representation are challenging traditional skills of communication and representation, (i.e., sketching, hand drawing and physical model making). The paradox facing architectural practice today is the integration of new media into a realm where traditional or manual forms of representation are ingrained into how we think, produce and communicate. We must ask ourselves, must new media be held to the traditional forms of representation?

Changes in practice as well as design education should look to new media particularly modeling and time-based media, with the opportunity for further exploration of our ideas, the creation of new forms, and a new vocabulary. The creation of new forms comes with a responsibility of seeking new forms of representation.

To achieve a level of fully digital investigations, a foundation in the area of new media must be provided for in today's demanding curricula. It is my position that if digital media is considered a tool for design inquiry then it must be integrated at an appropriate level where fundamental design methods are taught. The problems facing the integration of digital media stem from the fact our field is dominated by traditional methods of process, communication, and presentation.

I would argue that a digital immersion studio offers an opportunity for exploration unlike a traditional design studio (Figure 1.) But before studios take that step forward towards a paperless studio environment, a knowledge base in digital media must be in place.

This paper seeks to identify where that knowledge base in digital media should be applied and why digital media should be seen as a tool for architectural investigations. This paper will also touch on how the integration of digital media into an existing programs through the use of workshops and electives fail to respond to the need for changes at the curricular level that address the changes relavent to our time.

Figure 1. Traditional Design Studio

Why Paperless?

The "paperless" studio concept is not a new venture. Since the early 1990's, studio's in graduate programs like those at Columbia University have experimented and have fully integrated digital immersion environments for design exploration. It must be noted that this paper is written from the viewpoint of one seeking change within a program which until recently has been firmly entrenched in teaching traditional methods of design communication and exploration. It is from this position that this paper seeks to understand the process that would allow for the integration of a paperless studio into a curriculum of traditional media.

First we may ask, why is it necessary to provide a digital immersion environment in which traditional methods for design exploration such as physical models and drawings would be excluded? I would answer that question with the question, why does it seem satisfactory to exclude digital media when exploring with traditional methods. The validity of a "paperless" studio lies in the idea that digital media can change the process of design, the forms of design and how we communicate our design ideas. A comparison could be drawn between a "paperless" studio, one in which all other forms of representation and investigation is excluded, to a studio that has been instructed that the only medium for exploration will be casting. A casting studio would force change in ones process, forms, and experience. To draw a parallel to the digital immersion studio, one needs to become aware of the unique abilities of digital media, the process that must be altered, and the forms that now can be explored.

Integration: Building a Knowledge Base

To begin this discussion it must be agreed upon that digital media, specifically digital model making, is a tool for the exploration and investigation of space. Furthermore, it must be agreed that if digital investigations are tools to be employed for design inquiry then they must be taught as such and placed within a design schools curriculum where tools for exploring are taught. The initial stage of design, the concept, has the opportunity to engage the computer as an apparatus for investigation (figure 2). The introduction of digital media at an early level of design education provides the opportunity for the student to comprehend the use of the computer as a design tool instead of a tool solely for drafting.

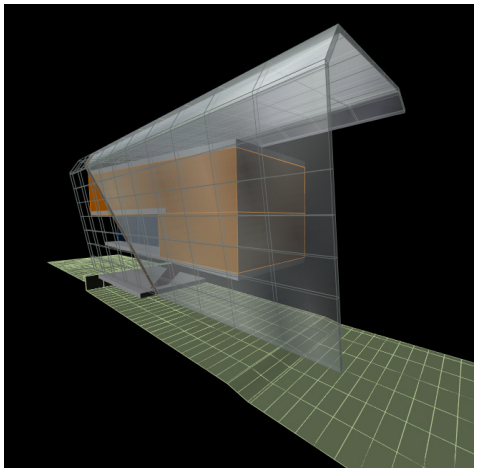


Figure 2. Future House concept sketch.

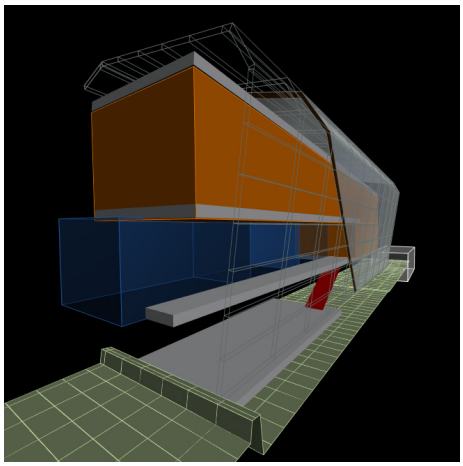


Figure 3. Future House concept sketch.

With the aid of digital media the way in which we

as designers convey or communicate is changing. Three-dimensional models communicate sequencing, materials transitions and assemblage (figure 5). As digital media is incorporated into the design process the student's ability to test and investigate ideas more thoroughly our ideas will lead to foreseen construction and material conflicts and a more informed builder. With the freedom of exploration in digital media and the complexities that arise comes the responsibility of documenting our designs for construction. Digital models and web-based project sites are becoming normal practice within the "real" world of building construction. As we become a more global society, the ability to transfer or communicate our ideas in a clear and timely manner is ever increasing.

Time-based media in the last few years has come to the forefront of digital exploration and inquiry. Software like Softimage, Maya, and Alias StudioTools has become more mainstream due to their use by Hollywood movie houses in the production of CG or computer generated graphics. These CG elements can be anything from people, toys, and scenes, to complete environments. The marriage between reality and the CG objects is reaching the point of seamless integration. I would like to offer two rationales for the use of time-based media in design education. The first and simplest to conceive is having the ability to create or simulate reality. As designers of the built environment, we seek ways in which to test our ideas. Working in a realm of artificial reality through the use of drawings, models and sketches we seek to convey some sense of the built environment. Animation software allows one to approach, to test and to investigate a simulated reality or "virtual" reality. The second rationale for the use of time-based media as a tool for investigation is the understanding of how time-based media can influence how and what we design. The ability to explore new forms and new connections to technology all is afforded to us in time-based media. Gregg Lynn describes the term "animation", in his book *Animate Form*, as "the evolution of a form and its shaping forces." (Lynn, 1999). The use of time-based media and high-end modeling software offer designers the ability to understand objects in space as having certain properties and influences over other objects. The assigned properties beyond objects' color and texture allow for pressures, strengths, and resistance to be tested against oneself as well other objects in a scene. Our sites for intervention have identifiable pressures that can be categorized and quantified. The application of these pressures can begin to shape and form the environments in which we design. The use of high-end animation and modeling software pushes us to explore new thoughts of materials and understanding of structure vs. skin. More attention to industrial design and the process of skin or shell as structure is open to investigation with the use of software such as Alias StudioTools.

The use of animation tools in the design of our environments must be done with the understanding of the computer as a tool for inquiry and exploration. The labeling of software as a "pet" should be mentioned at this time (Lynn 1999). Lynn describes the use of software in this way because pets are domesticated and so should our use of the computer. The haphazard application of tools such as animation software allows the designer to be removed from the process and the software to be in control of the outcome. As designers we must be able to control the software and outcome. The ability to push the computer as a tool for design comes with a responsibility of understanding its' limits and its' role as a tool for inquiry.

Process:

Digital media is finding its way into design studios around the world. The question is will digital media become part of the process of design and be truly integrated into the culture of architectural education? Traditionally, design curriculums have stressed "process" through the use of physical modeling, orthographic drawing, and sketching. This process is seen through the use of multiple drawings in various media and the

revisiting or revising of previous studies. A unique characteristic of the physical process is the trace or recording is left visible. The layering of information provides certain richness to the exploration. The ability to see where one is presently and where he or she came from seems to be a benefit of working in a physical or tangible medium. Digital media can offers those same benefits as well. The history of a project and process of design must be evident in the techniques we employ. How is this accomplished in digital media where the original is ever changing and nothing is solid? Erasing and revising a digital file causes the history of an object to be lost. One solution to this dilemma is demonstrated in a two-week study of an urban house.

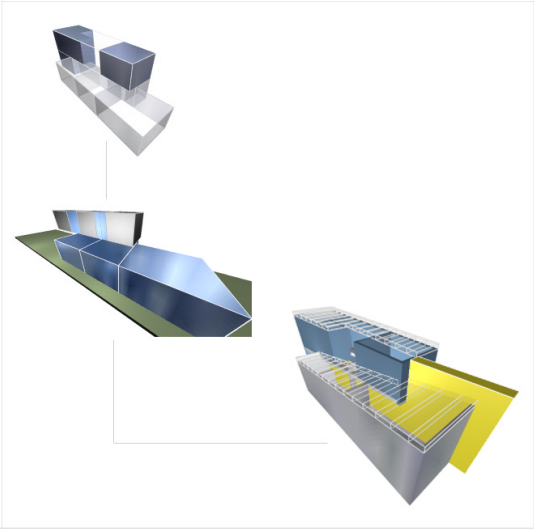


Figure 4. Process sketch.

The study uses the modeling software to the benefit of "process"(figure 4). Each time the file was opened and each time revisions were made a new file would be saved, providing a record of the past. New ideas for exploration were saved out, establishing another recording. Recordings, throughout the design process, allow one to see the evolution of a project from various concepts to design development.

Presentation:

Traditional methods of representing or communicating our ideas have employed drawing, casting, gluing, and cutting. These physical skills allow us to construct vehicles of representation from the charcoal drawing, to the form-core model, to the ink-wash perspective, to the hard-line plan, section, and elevation. These methods are employed to provide the viewer with a glimpse of one's thoughts and concepts of space. The products of these methods find there way onto boards and under plexi-glass vitrines. The ease with which one can critique a project that sits physically before us has provided a comfort level not easily removed when the methods of representation change to the intangible products of digital media. A challenge for digital media is in the area of presentation. Traditionally, physical models and drawing have been the vehicles of communication. Will digital media continue to be held to the traditional forms of presenting or will we search for new forms of presenting digital media. As one investigates the changes in design education and the influence digital media are having on the design process, the form of representation must be questioned as well. Traditional forms of representation must not set the standard to which digital media must conform; instead digital media must be allowed its own form of representation.

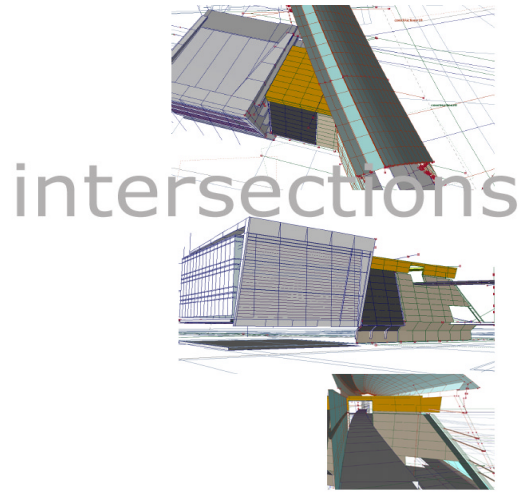


Figure 5. Intersection modeling.

Traditional forms of representation vs. Digital media opportunities

The forms of representation in the traditional design studio have been the use of physical models, hand-drawings, and even to some extent the use of two-dimensional CAD applications providing orthographic drawings. As the tools for inquiry change so should the products of this inquiry. As we transition from the physical/tangible forms of traditional media to digital media, new opportunities of representation must be investigated. These new methods may include real-time modeling, web-based interactive models, QTVR and animations. Digital media, particularly three-dimensional modeling, allows for technology transfer between design and industry, from digital to physical, through the use of rapid prototyping machines. This fusion between industry and architecture will allow for the investigation of new forms and new materials. The use of new media, the construction of new forms, and new techniques for provide a new ground for critique.

Figure 6. Integrated Studio Environments

Computers in the Studio

Moving toward a "paperless" studio, the question of how to physically place computers into the studio is not the issue, that is a financial dilemma on the part of the college or the student, the larger issue is a pedagogical one of integration. How to infuse the computer into a design process, becomes the greater question (Figure 6). Within the culture of design education where does new media find its place? I would argue that its' place is at the beginning. The computer is a tool for inquiry and as educators our curriculum provides those tools in the lower division design sequence. The success of a "paperless" studio will rely on the ability of its students and faculty to implement these new digital tools and change the culture of the studio environment. In many cases students want to incorporate digital media, animation, and modeling into their studio work, but the schools do an inadequate job of providing the needed knowledge base. If students are not adequately taught the digital design skills at the appropriate level in their education, digital media will not become part of a process of design and upper-level studios will be degraded to instructional labs for software training. In many cases upper-level students are forced to teach themselves software at the detriment to their studio investigation

Through technology initiatives such as workshops, electives and most importantly curricular changes the ability to build a knowledge base becomes a viable opportunity for the digital exploration of architecture.

Workshops:

Workshops for digital media provide a quick fix in many cases but offer the least amount of change from a culture deeply, rooted in traditional methods of design inquiry. Workshops in new media do provide the first step toward building a knowledge base, but do not acknowledge new media as an integral tool for design. Workshops, while providing a limited introduction to new methods of design, offer little in the way integration into a design process. The introduction of workshops are viewed as afterthought, one that is an option for students and not an integral part of design inquiry.

Electives:

Electives in digital media such Form•Z, 3D StudioMax, Softimage, Alias provide the needed time and focused effort to understand and become knowledgeable in a particular application. The greatest problem with electives is that they are often not made

available early within a design curriculum thus students are left to take these electives at a senior level. At this point the opportunity to provide new media as a pedagogical endeavor has been weakened. Students seek technology electives as a means of becoming more marketable not as a means of altering ones process of design. As educators we have the opportunity to put forward the idea that digital media is a design tool to be integrated into the process from the beginning. As educators we should stress to students that digital media are design tools to be integrated into the process from the beginning.

Curricular changes:

Wholesale curricular changes that incorporate digital media into the student's foundation years are necessary to move into an environment where computers become a transparent tool for architectural inquiry. By changing curricula, schools are acknowledging digital media and actively seeking its integration with the culture of design education. This paper has sought to point out that digital media is another tool for design inquiry. If in fact digital media is a tool for design one must ask, where is the most appropriate level for teaching design tools and means of representing ideas. Early in the development of designers we seek to provide them skills necessary for investigation, exploration and testing. The advances in digital media over the last five years have been phenomenal and what the next five years will bring can only be imagined. Design communication courses currently being taught in the early years of design education must evolve and reconcile the integration problems of digital media for the success of a program seeking to merge traditional media and new media. With the knowledge base built early within the design sequence opportunity for skill development and true integration within a students process of design is accomplished and a step toward the paperless studio is made.

Bibliography:

Lynn, Greg. Animate Form. New York: Princeton Architectural Press, 1999.

Endnotes:

[1]Greg Lynn, Animate Form, (New York: Princeton Architectural Press, 1999) pg.9.

[2]Lynn, Animate Form pg.19-20.

Illustrations:

Figure 1, "Traditional Design Stuidos." Image from Second Year Design Studios at Ball State University, Spring 2001.

Figure 2, "Future House Sketch." Image a concepts for a future urban house. June 2000 Frederick Norman author.

Figure 3, "Future House Sketch.." Image a concepts for a future urban house. June 2000 Frederick Norman author.

Figure 4, "Process Sketch." Images from Green Houses Competition, City of Chicago, July 2000, Frederick Norman author.

Figure 5, "Intersections" Images from the Telenor Competition, NBBJ-Seattle, 1998, Joey Myers and Frederick Norman authors.

Figure 6. "Integrated Studio Environment." Image from Fifth Year Design Studio at Ball State University, Spring 2001.

Teaching Statics and Strength of Materials Using Digital Technology

Shahin Vassigh
Assistant Professor
School of Architecture and Planning
State University of New York at Buffalo

Introduction

Developing innovative approaches to education is not unique to architecture, but as the technical component of a creative degree program, developing innovative approaches to the teaching of structures within the architecture curriculum is not only desirable, but absolutely necessary. The fundamental problem is that although understanding structure lies at the core of the education of the architect, architecture faculty and students struggle with a traditional engineering-based approach to structures instruction, which is increasingly proving to be ineffective in the classroom.

The traditional engineering based approach to teaching structures is largely a product of the historic development of scientific thinking, the evolution of the engineering discipline and the changing role of architecture. The growing role and influence of the engineer within the design and construction of the built environment has lead to the introduction of sophisticated mathematical models into the building construction process. As a result, the scientific method and mathematical rationalism have become the dominant models for teaching structures to both engineering and architecture students.

Architecture students, however, have very different educational needs, technical capabilities and will apply structural design principles differently than engineering students and professional engineers. The unfortunate mismatch between most structures curricula across the country and their students has a fundamental root problem. The instruction based on engineering approaches is highly quantitative, communicating even basic concepts using an advanced mathematics nomenclature. However, architecture students have neither the background, disposition, nor time to master the mathematics skills required to understand or utilize a system based on highly mathematical models. They therefore quickly become uninterested, frustrated, or even intimidated by the structures curriculum.

Facing this dilemma, many architecture faculty have developed new methods, alternative teaching materials, textbooks and other tools for communicating structural principles that respond to the needs, capabilities and perspective of the architecture student. Two recent textbooks and a teaching manual best demonstrate how creative approaches can be used to facilitate the understanding of structural concepts for students. The first book —Shaping *Structures* is written by Waclaw Zalewski and Edward Allen (Waclaw Zalewski and Edward Allen, Shaping Structures). In *Shaping Structures* the authors extensively utilize graphical techniques for introduction of statics principles and finding forces in structural elements such as trusses, arches and cables. Both numerical and graphical techniques are introduced in a highly visual context to appeal and pave the way for teaching statics concepts to students who have very little mathematical background. Christine Theodoropoulos stated her appreciation of Zalewski and Allen's methods:

But the rationale for learning statics through drawing as a means to becoming graphically as well as numerically fluent is compelling. *Shaping Structures* provides educators and students with a tool that effectively merges qualitative with quantitative learning (Christine Theodoropoulos, *Journal of Architectural Education)*.

Taking a step further, the authors also use the graphical method as a tool for generating form, which not only enhances the validity of the subject

of "structures" for students in the architectural design context, but it suggests another possible venue for producing creative and expressive architectural design.

Fuller Moore's *Understanding Structures* places an emphasis on the visual description of basic concepts by using descriptive force diagrams and sketches to demonstrate structural behavior under load application (Moore, Understanding Structures). By using a series of case studies he provides a rich visual context for discussing the subject.

In a completely different format, *Demonstrating Structural Behavior with Simple Models* is an instructor's manual and a laboratory guide written by Richard Kellogg (Kellogg, Demonstrating Structural Behavior with Simple). Kellogg details a series of hands-on experiments that are designed to provide first hand experience for observing structural behavior and failures.

Digital Models

Building upon this significantly creative work and the recent developments in digital technology, I have developed a series of digital animation instructional tools. Using computer-generated models, interactive images, and animation, this series of teaching tools integrates quantitative engineering methods with qualitative approaches using a range of digital visualization devices.

One of the greatest advantages of using digital animation technology is that it enables us to fabricate visual environments custom made to demonstrate complex concepts in an easy to understand visual means. These digital environments can also be manipulated to emphasize or de-emphasize certain structural or material properties. Material behavior can be exaggerated to convey certain principles, which are not normally visible to the human eye, such as the stress levels in a beam cross section or deformation of a rigid frame under lateral loads. Members of a structural system can be removed or added to clarify the analysis, or the load travel path diagrams can be animated to demonstrate how the load is collected and distributed in a structural system.

Finally, including a recorded narrative with each animation enhances their teaching effectiveness even more. By explaining working principles with audio, students can focus on the animation and directly connect complex structural concepts with visually demonstrated material or structural system performance, rather than extrapolating these ideas from written text and mathematical symbols. Each animation also has playback controls to slow, stop or repeat the animation at different frames.

Two such digital animation-teaching tools I have used extensively with great success in the classroom are teaching of S*tatics* and S*trength of Materials*.

Strength of Materials

Statics is a branch of mechanics that deals with the analysis of rigid bodies at rest. In order to make the analysis possible all the structural elements are assumed to be completely rigid. However, actual structures are not absolutely rigid and will deform when subjected to loads. These deformations are usually small and do not significantly affect the equilibrium condition and the analytical procedure, but they are very important for understanding

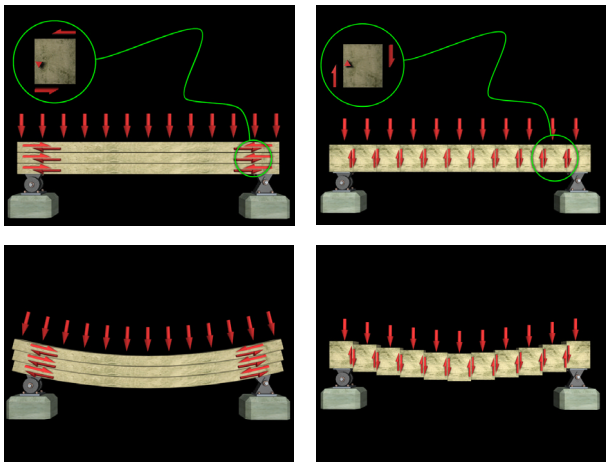


Figure 1 (click for QuickTime animation)

material behavior and its resistance to stresses.

In strength of materials, understanding deformation mechanisms can help students to learn definitions and working principles, the nature of forces (tension, compression, torsion, etc.), and the structural logic for form selection. For example, Figure 1 shows stages of simple animation demonstrating the beam behavior in response to a uniformly distributed load. As the load is applied and the beam begins to deflect and deform, the adjacent parallel components of the beam slip in horizontal and vertical direction, thus visually explaining the mechanics of beam deflection.

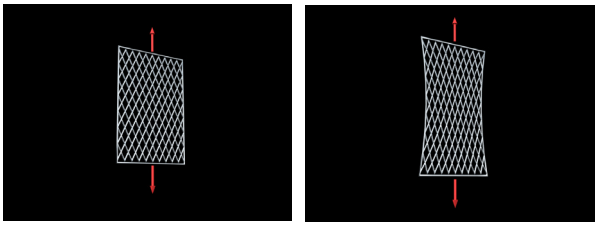


Figure 2

Concepts of deflection, horizontal shear and vertical shear are all communicated with animation using exaggerated behavior of the beam, as it is flexes under a load.

Concepts of tension, compression and torsion can all be visually demonstrated using the same type of modeling. Figure 2 shows two frames of an animation of a steel grid undergoing tension. As the member is pulled, the exaggerated deformation shows how the material will change its dimensions and experience strain.

Presenting the stress-strain relationship in a graphical format is a standard exercise for comparing the strengths of various structural materials and introducing Hooke's law and modulus of elasticity. Typically these graphs are plotted for various stress levels and the resulted strain, based on laboratory test results performed on a specimen. The common practice is to use these graphs as a quantitative tool for determination of the modulus of elasticity. With a slightly different approach these graphs can become an important device in understanding material behavior at various stress

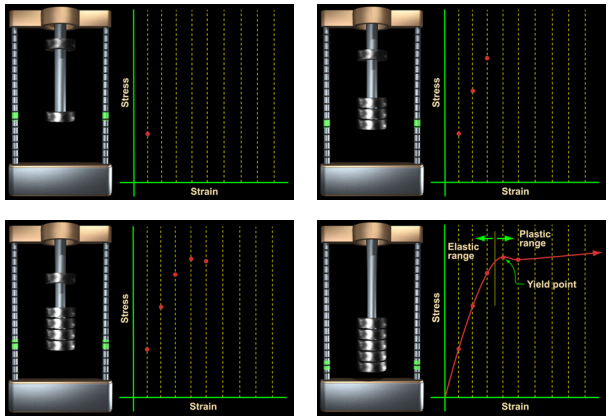


Figure 3

and the stress/strain relationship at a conceptual level.

Figure 3 shows four stages of an animation simulating a laboratory test by subjecting a steel bar to tensile stresses and showing the results plotted in a graphical format simultaneously. In the animated model, increasing stress is achieved by dropping a weight on the steel bar. Each time a weight is dropped, the steel bar elongates slightly and the measured elongation is plotted against the stress. At a certain level of stress after a few weights are dropped, the bar elongates radically, indicating permanent deformation and eventually the failure of the steel bar.

Statics

By using slightly different criteria, almost all statics principles such as definition of force systems, equilibrium conditions, two force members, moments and couples can be explained more clearly and effectively using the digital animation models. For example, simple computer generated models can

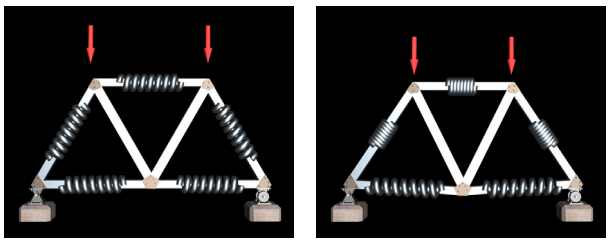


Figure 4 (click for QuickTime animation)

be used to show load travel path in trusses and delineate the tension and compression members accordingly. This is achieved by using two sets of digital models. The first set use truss models composed of spring like members. Upon load application, the model is animated and the spring members will be elongated or compressed according to the effect of loading, visually demonstrating the behavior of the tension and compression elements of the truss. Figure 4 shows one of these models.

The second set of truss models demonstrates the behavior of truss members made of different materials. For example, models composed of wood in compression member and steel cables used in tension members are tested under loading. When these models are not loaded the cable members show exaggerated sag. As shown in figures 5 and 6 when the load is applied, the cable members stretch and tighten up demonstrating the effect of tension. The behavior of compression members is demonstrated by a change in the color intensity of the members. When a wood truss member receives its loading share, a change of color is observed in the member. As the member is compressed more, the color intensity of the member increases at the center and the member becomes brighter, emulating the compression of the wood fibers.

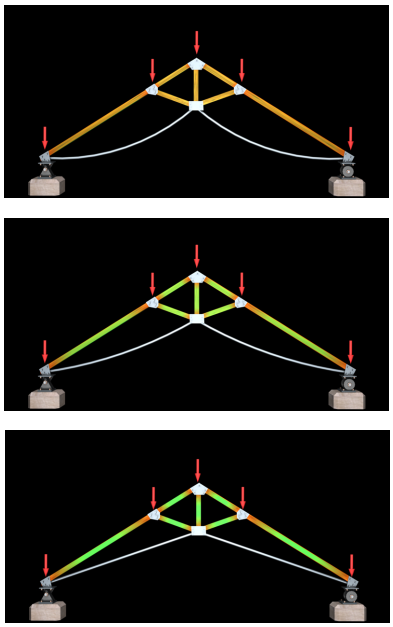


Figure 5 (click for QuickTime animation)

Closing Remarks

The central underlying principle for the development of these teaching tools is to provide a highly visual and direct means of communicating concepts and grounding them in experience. Particularly for Architecture students, who are visually and qualitatively inclined by nature and training, using powerful graphics, animation, and narration, can help build a strong understanding of complex structural concepts and principles. It is also possible the use of digital modeling and high-end graphics can also bring a new level interest and excitement to the subject matter, changing the way structures is treated within the architecture curriculum.

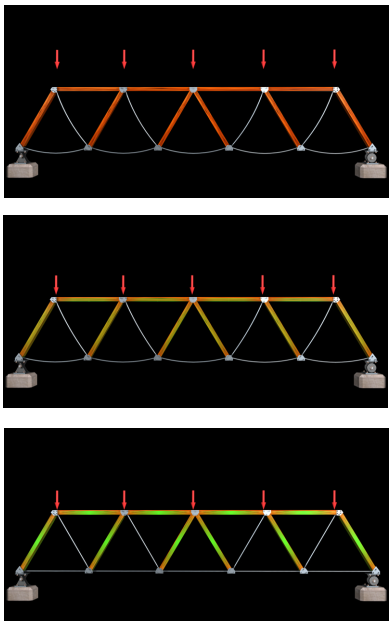


Figure 6

Bibliography

1- Waclaw Zalewski and Edward Allen, Shaping Structures, John Wiley & Sons. Inc. New York, NY 1997.

2- Christine Theodoropoulos, *Journal of Architectural Education*, Feb. 2000 vol. 53/3

3- Moore, Understanding Structures, WCB/McGraw Hill, New York, NY 1999

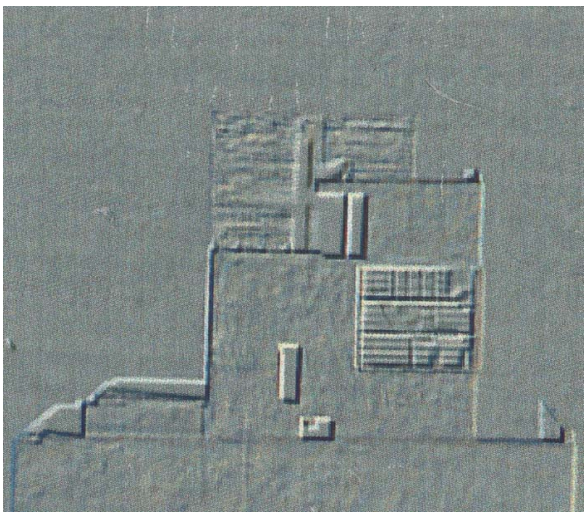
4- Kellogg, Demonstrating Structural Behavior with Simple Models, Published by the Author, 1994

Ciao! Penn State:
A Scaffolded Learning Environment

Darla V. Lindberg
Associate Professor of Architecture
Michael Halm
Center for Academic Computing

Introduction

In "Technics and Architecture," Cecil D. Elliott tells the stories of building materials and systems development, regardless of time and place, to include a variety of solutions used simultaneously. Politics and social events impact advancement as much as any need or inventive problem solving. And because work is also a human activity, the eventual improvements are only that because of the noteworthy share of failures, misjudgments and vainglorious efforts along the way. In Elliott's words, "A building is at the same time an object, an investment, and a cultural and personal expression of beliefs. Any change in the way buildings are built or the way they look must be tested against a variety of standards, their relative importance being somewhat different for every project. This truism explains why certain technological aspects of architecture have been readily adopted and others have been long delayed. For instance, elevators were a vital factor in the economic and social changes related to the great sweep of urbanization, and therefore elevator technology was immediately accepted and quickly developed. No similar urge spurred the development of a more rational system of plumbing and waste handling" (Elliott, 1993).



(Figure 1. Strategy in synthesis impression))

Teaching these development stories as a *strategy* for meaningful design invests in the understanding that the built environment ought to be a product of architecture-as-art and architecture-as-praxis. Architecture for the built environment, then, is meant to be experienced, meant to be physically inhabited, meant to be used, and meant to co-exist with other buildings within its context. That context is one that includes current and local labor and economies, a respect for the earth and sky that sustains us, and a work that intentionally does not distance itself from its constructed and material inheritance. Work that is decidedly wise about the circumstances that surround health, safety, welfare, construction, and systems integration is work that doesn't compromise itself within the category of some personally reflective and

creative muse. Rather, it celebrates the resultant translation and synthesis of critical design decisions as *an architecture,* a representation, if you will, of wisdom, strategy and choice.

Background

The work presented here is the result of a collaborative effort investigating this *representational* approach to design decision making and the teaching delivery system that might encourage it. As Boyer and Mitgang point out in their report on architecture education and practice, "Architecture education is really about fostering the learning habits needed for the discovery, integration, application, and sharing knowledge over a lifetime" (Boyer and Mitgang 1996). A summary of the research includes the recognition of the problem learning process requiring effective information (Bazjanac 1988). The acquisition of accumulated knowledge impacts the cyclical, iterative, rethinking of the problem (Alexander 1971). Confusing or "wicked problems" compound the process because the solutions, like the problems, aren't easy to identify. There are hierarchies and consequences to problem definition and design solutions (Rittel 1972). In fact, there may be evidence supporting contradictory or opposing opinions for which no single, correct solution can be determined (Kitchner 1983). Only when ill-structured problems can be celebrated as part of a conceptual process can they help frame the problem (Schon 1986), (Jonassen 1997). When problems can be conceptualized as realistic situations domain-specific knowledge is sought, i.e. disciplines (Bransford 1993). Disciplines gather an expertise and experts contribute to effective problem definition. The inheritance of a repository of context-specific information informs learners of precedent attempts at similar problems (de Jong & Ferguson-Hessler 1986). Learning theories have moved away from objectivist ideologies and towards practice and reinforcement to provide an overview of the process of problem identification (Jonassen, Peck, Wilson 2000). Constructivist learning environments facilitate learning by doing through knowledge representation. Problems, even when virtual, will take on an existent quality because learners are engaged in meaningful projects requiring them to explore, experiment, construct, converse and reflect (Jonassen & Land 2000). First developed during World War II as a mechanism for producing reliable training, its origin is in behavioral psychology and communications theory. By applying feedback and practice to the basic communications model, knowledge transmission and reception meant a "strategy" for application was learned. It was this quality that seemed especially important to introduce to the student hoping to know when and how to use a particular kind of information as how daylight will impact supplemental heating to a room or when occupancy use group rethinking can effect an overall building configuration. Particularly when it came to hard thesis questions, *strategy* would allow an investigation of the "attachment" or the process of the "edit", even a particular gesture involving a "graft" to be translated in a meaningful way and applied through the praxis intentions of the work.

Figure 2.(Andrew Lefkowitz Student thesis work)

Context

Each thesis student in Architecture at Penn State is required to work on an independent thesis their fifth year. Because the thesis is student driven, the topic and emphasis of one project may be radically different from any other in the class. What is expected, however, is that each thesis project investigates an issue or dilemma in an architectonic way through a thoroughly considered building problem. Therefore, each design thesis will feature components of a thoroughly considered building problem, i.e., siting, structure, materials, environmental systems and a building envelope along with sustainable practices and energy conscientious design. Students register for two semesters (Fall and Spring) to complete the requirements of the Architectural Thesis.

Attachment: home and the urban non-place

The traditional city suffers from the adaptation of reductivist tools of organization (districts, corridors, networks, zones) not only in its physical form but also in the manner in which it is seen and acted upon by its inhabitants. In particular the transition spaces effected by circulation corridors erode a city's richness into banal diagrams denoting private and public interest both in scale and in texture. This wasn't always the case. Paul Groth's work on urban housing before the "Cold War" notes a time when a local café augmented a small private kitchen or a sidewalk chess table shared the respectable social status of any private parlor or club. Density compromised national security and there was in invested interest in decentralizing the urban place.

The intention of this thesis is to investigate the architectural nature of *home* not as an object of the individual separate from the urban, but as a process of *attachment* in both a construed and constructed way intent on the eventual assimilation of the private into the public.

(Figure 3. Excerpt from student thesis)

Systems Integration

Students also register for a support course in the spring semester of their thesis year. This course, Integrated Building Systems, was created to "scaffold" the Architectural Thesis as a guidance tool in the process of decision making for multiple systems, for example, those linked to labor and construction, finance and economies, research and consultant expertise

The content for Integrated Building Systems, the support course to the thesis, consists of six modules. These modules recognize decisions in a holistic process as consequential and linked to each other. The individual thesis determines the emphasis and order of application in the project.

Module 1: Occupancy and Use Designation

- Historic context for public safety
- Developments in fire prevention
- Proximity, separation, zoning

Module 2: Siting, Daylight, Program Zoning

- Siting and the zenith of the sun
- Room proportions and natural light

- Developments of artificial light

Module 3: Massing and Lateral Stability
- Stable Configuration
- Structural components to bracing
- Circulation systems, egress
- Accessibility

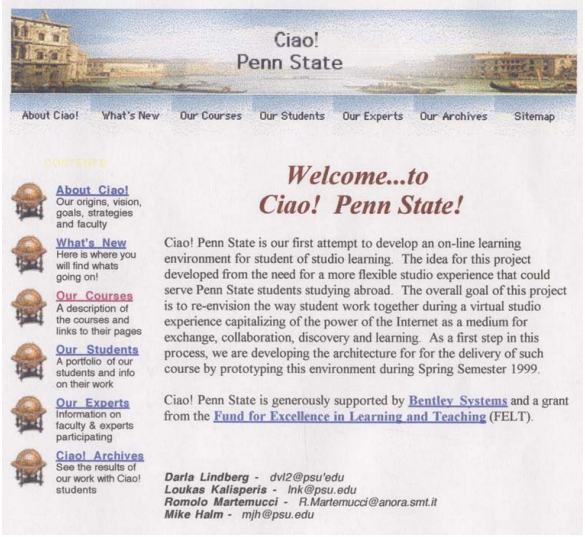
Module 4: Structural Criteria for Selection
- Historic context for construction
- Labor stories and economies
- Inventions, innovations
- Decomposition, resultant forces

Module 5: Supplemental/Alternative Systems
- Utilities and operations
- Spatial and health qualities
- System criteria and configuration
- Alternative and innovative systems

Module 6: Building Envelope
- Technology and the wall section
- Poche, structure, space
- Contiguous systems
- Climate mediation

The uniqueness of each thesis demands this support course can not be taught in a traditional linear way. The course contents need to be accessed as a resource while instilling the "wisdom" of layers in decision making as consequential and linked. And since each thesis tends toward multidisciplinary issues, it seemed appropriate that students learn to guide decision making as a corresponding responsible and responsive act potentially linking community and technical expertise.

Herein suggests a potent opportunity for an asynchronous teaching environment. Therefore, course delivery would not be linear and separate, but linked directly to the specific process of the student and problem of the thesis. The potential expansion of contributors to a learning situation would promote debate, rebuttal and challenge the hierarchy of traditional content delivery.



(Figure 4.Web site introductory page)

Ciao! Penn State

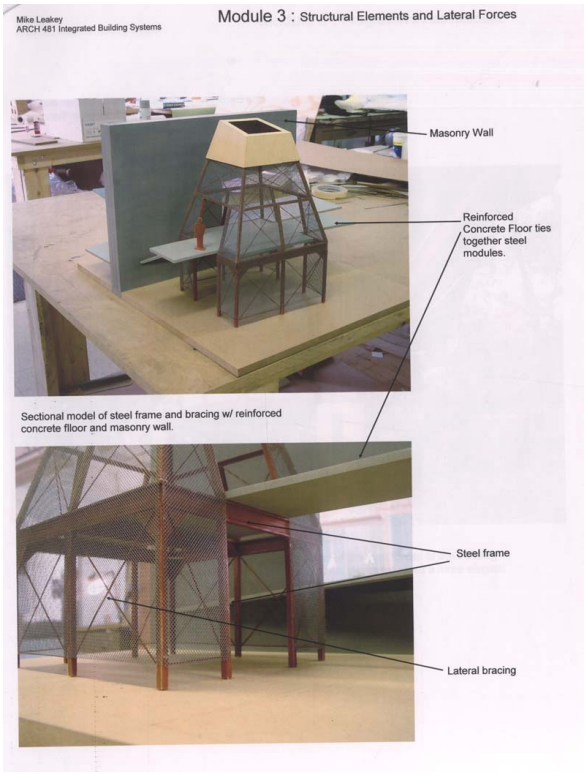
http://ciao.arch.psu.edu is an electronic environment as the result of Ciao! Penn State, a research project funded by the Center for Excellence in Learning Technologies at the Pennsylvania State University to explore this potential. A particular goal of the research would be to investigate problem based learning for remote sites (a study abroad program in Rome, Italy or distance learning programs in the United States). *However, questions critical to the research centered on the substantial and qualitative use of information and expertise to significantly effect the design outcome, whether local or remote.*

With this in mind, the research focused on the ontological relationship between the content systems of a discipline (found in the curriculum in academia) and their ties to a particular design problem. In other words, course material and expertise are rendered relevant based on the relationship they have (perceived or actual) by the design problem. On the surface this appears appropriate and reasonable and remains a

teaching model few challenge – the problem drives the investigation. The dilemma exists not in the didactic importance of the problem, the level of involvement or complexity, but in the *place and nature of the problem*. Consequently, material that may be critical in an existent or real world is very different from the material necessary for a non-existent or ideal world. This articulation doesn't become problematic except the results teach a "strategy" to decision making that ignores the relationship of other criteria to valid and critical judgments in design. It is any wonder Architecture is an 'old person's profession.'

This isn't the case with other disciplines where strategy, even those requiring quick response decision making, is recognized as a critical part of the learning outcome. Physicians have a series of protocols for litigiously defensible practices. Medical students are taught to use those steps as they record symptoms and determine diagnosis. Business students analyze case problems to see the strategies used in decision making. Undercover police work relies on an instinctive knowledge of the legal parameters they need to work within for split second judgments in action.

The importance of this research project, then, was to locate the place and nature of important "strategy" (choice, judgment, and wisdom) in design decision making.

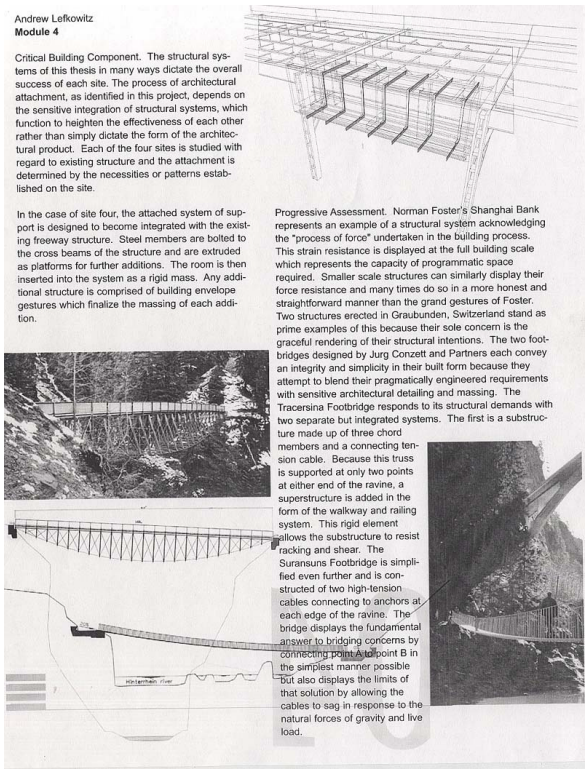


(Figure 5.Student integration module: Michael Leakey.)

The Scaffolding

The first thing the modules require of the student (the thesis student in this study) is to consider each one as it relates to their particular design problem. Since these students have taken building site, materials, structure and engineering courses prior to entering this year, the modules prompt the students to consider aspects of design that have implications to other systems in the building. Students read, examine expert links, are presented exemplar works and are asked to consider through the isolation of each module topic some of the particulars associated with the eventual integration. It begins to connect to the thesis problem when a student can identify ideas for conceptual beginnings enhanced by aspects in the modules (i.e., program zoning of particular massing enables the building configuration to be

inherently stable, or the entire building is zoned to work as an egress system.)

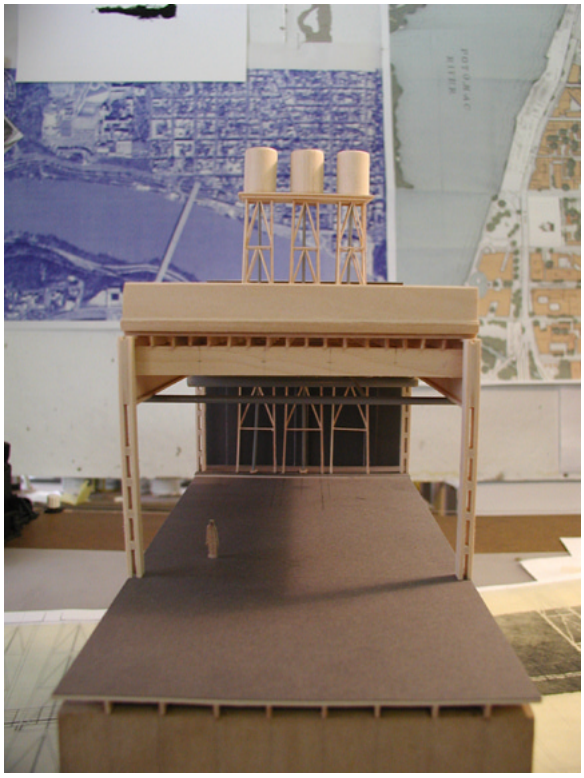


(Figure 6. Student integration module: Andrew Lefkowitz)

Students are guided to readings that describe inventions or developments of systems and they interpret context, economies and political climate as critical determiners in the resultant opportunities and challenges in design. As a resource each module tracks the development of historical contributions (implications, consequences, regulations) in order to invite the opportunity for change. By applying the information of each module to the thesis, feedback is taken into the conceptual understanding of the project. The next module is layered onto the previous one and the accumulated knowledge persuades or contradicts the validity of those earlier decisions. Depending on the nature of the thesis, the preferences of the student or the goals called up by the problem, some decisions are judged preferable over others in the representation of the knowledge gained through the modules. This is quite different than the expectation that a student will apply the knowledge from a course in structures or a course in heating, ventilating and air conditioning to the thesis problem. In a similar way, the progressive assessments (essay feedback of concepts discussed in the module) provide students with a way to think through the theoretical issues espoused by the thesis problem and translated through the work.

The thesis students work on all the modules independently and apply them to their own thesis problem. Expert links allow the student to work at a level of expertise they find appropriate or significant to the work. Archives of past student work give critical guidance to students because the work is purposefully addressing the issues (for example, creative occupancy use group interpretation and consequences) instead of blurring those wise professional decisions in a glossy journal photograph.

At mid-term, the students concentrate on the final presentation work of the thesis problem. At this time, emphasis is placed on a collaborative research project in the integration course. The intention of the research project is to allow the students to test what they have learned about *strategy in design decision making* by assessing the work of others. Students select a real project they can visit or one they are familiar with from their foreign travels. They consider the project, the client situation (budget, process, program) and they review the consequences of particular decisions related to code, zoning, room placement and section, siting, massing, structure, systems and the resultant responsiveness of the building enclosure. These research projects are proving to be a valuable resource for younger students as they grapple with questions dealing with significant building massing for a particular typology, i.e., a library, or labor and cost implication for a decision involving a particular structural and enclosure system.

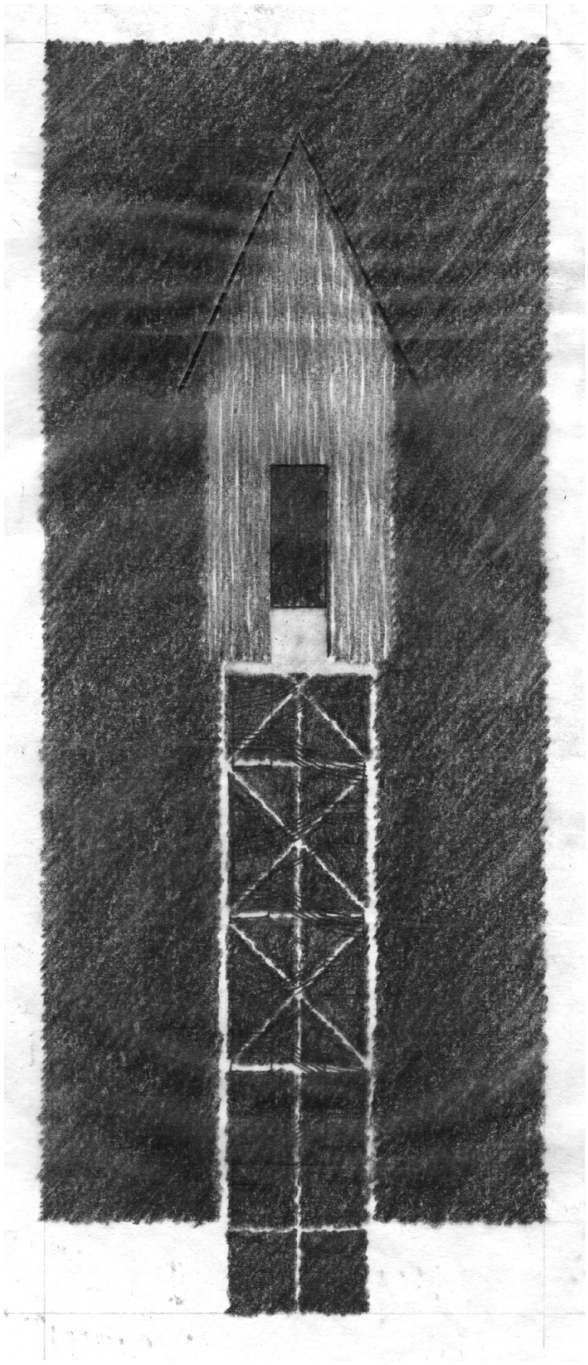


(Figure 7. Student integration module)

Conclusions

Within the theoretical framework of learning by doing, discovery and strategy are mutually inclusive tools for design thinking. Students can consider implications and repercussions for certain design decisions without taking anything away from the discovery process of creative thinking. Thoughtful understanding of the designation of a particular occupancy use can guide a student quickly to construction types and material assemblies without slowing the conceptual process. In fact, the opposite is more often the case. Students know where to start and why to start, as evidenced by the use of archive work.

The knowledge added to design education by this research and project is the awareness of a need for coupling or 'scaffolding' device for certain kinds of courses made especially possible via asynchronous teaching. Certainly faculty can be expected to share information as mentors or students can be expected to continue translating and transferring information on a need-to-know basis. But the development of non-linear teaching mechanisms (in this case, the clear articulation of the six modules of content) deliberately scaffolded or linked to other critical coursework (the thesis design problem) instills the importance of *strategy* to critical thinking about consequential and linked decisions in thoughtful and responsive work.



(Figure 8.Student integration module))

Bibliography

Alexander, Christopher. 1971. "The State of the Art in Design Methodology," an interview in Design Methods Group Newsletter, Vol. 5, No 3 (March 1971), pp 58-61.

Bazjanac, Vladamir. 1988. Symposium on Basic Questions of Design Theory, "*Architectural Design Theory: Models of the Design Process."* New York: American Elsevier Publishing Company. pp. 3-19.

Boyer, Ernest L. and Mitgang, Lee D. 1996. *Building Community: A New Future for Architecture Education and Practice*. Princeton, N.J. The Carnegie Foundation for the Advancement of Teaching.

Bransford, John D and Stein, Barry S. 1993. *The Ideal Problem Solver: A Guide for Improving Thinking, Learning and Creativity*. New York : W.H. Freeman

de Jong, T., & Ferguson-Hessler, M.G.M. 1986. *Cognitive structures of good and poor novice problem solvers in physics*. Journal of Educational Psychology, 78, 279-288.

Elliott, Cecil 1993. Technics and Architecture; the development of materials and systems for buildings. Cambridge, Massachusetts; MIT Press.

Jonassen, David and Land, Susan. 2000. *Theoretical Foundations of Learning Environments*. Mahwah, N.J. L. Erlbaum Associates.

Jonassen, David H, Peck, Kyle L, and Wilson, Brett G. 1999. Learning with Technology_ A Constructivist Perpective. Upper Saddle River, N.J. : Merrill

Jonassen, D.H.1997. *Instructional design model for well-structured and ill-structured problem-solving learning outcomes*. Educational Technology: Research and Development 45 (1).

Kitchner, K. 1983. *Cognition,Metacognition, and Epistemic Cognition: A three-level model of cognitive processing.* Human Development 26:222-232.

Rittel, Horst, W. J.and Melvin M Weber. 1972. *"Dilemmas in a General Theory of Planning*". Working Paper No. 194, Institute of Urban and Regional Development: University of California, Berkeley.

Schon, D. 1986. *Educating the reflective practitioner: towards a new design for teaching and learning in the professions*. San Francisco: Jossey Bass Inc.

blobs, wiggles, folds and distortions

GAIL PETER BORDEN
North Carolina State University

> whenever technology reaches its real fulfillment it transcends into architecture[1]
> **-mies van der rohe**

The borderland existing in contemporary digital technology is ***the*** unexplored terrain. Representing the same manifest destiny of the newly discovered American continent, the self-sustainability of westward expansion and monetary potential of the 1980's world of high finance has each been usurped by the current opportunities of the digital realm. The new landscape breeds promise and possibility represented by the edge condition and the outlaw: the individual that employs the lack of orderly cultural domination to re-evaluate their moral boundaries by defining their own way of living. The train-robbing bandits have redefined the six-shooter as John Draper discovered that a Cap'n Crunch™ whistle produces a tone activating AT&T's free calling in 1971 birthed the hacker.[2]

A revolution is underway. The beginning of the twentieth century witnessed the industrial revolution where material innovation and mechanized production transitioned the conceptual considerations of architecture. Buildings reached the sky, mass-production increased product availability, and industry altered social boundaries. The late 20th century, led by information, has re-positioned every aspect of modern life from the automated coffee maker to the patriot missile system[3]. Each innovation forces transition by expanding the sphere of knowledge and experiences to engulf terrains previously unconsidered or even conceptualized. Architectural production and design methodology have similarly been altered. The traditional parameters and methods have become anachronistic. Their augmentation has resulted in an evolutionary cyborgenic[4] hybrid governing the methods of interface operation.

The borderland between the digital realm and the physical realm is constructed with virtual technologies. A physical fissure, through a conceptual transition, snaps the historical continuity of cognitive production with schizophrenic operation in multiple distinct realms within the same framework[5]. A trigger mechanism initiates the oscillation of the mind between each of the detached personality realms where transactions operate uniquely to each of the parallel realities. The body physically experiences everything, but the mind compartmentalizes and separates. The individual becomes multiplied, existing in several inseparable realms simultaneously with each varied personality representing the polarities of the human condition. The digital realm employs this hybrid mentality without functioning with the same independence or naivety, but rather simultaneously indulging the cognitive responsibilities by mapping the history and culture of the collective conscious to the physicality of media. This tactile meditation demands the synthesis of the instinctual where the cognitive joins with the biological to allow for an interaction briefly merging man and machine generating a cyborg.

Biologically, the hierarchy of the mind and the body facilitating compartmentalization is discarded to permit the instinctual to transcend the systems, methodologies and barriers of physical occupation. The physicality of the interactive system assimilates the tactile and visual abilities of interface to extend the physical realm by bridging the cognitive realms of the irrational mind with the obsessively ordered numerical realm of code. One wields the body to traverse a cognitive landscape and produce an ephemeral intellectual result the way one wields a hand tool to accordingly govern a physical result. The elaboration of this primitive foundation

alternates the parameters by transitioning form and production from the physical to the cognitive realms.

The manual dissection of this process reveals the impact of the new digital media upon the production of architecture. In recent years, with modernism and the mass production of materials, greater abilities and greater constraints have confronted the architect. The individual governing is usurped by the collective conscious of various concerns and talents from multiple professions. The collaboration transitions the focus of architectural production to the media of: drawings, models, textual specifications that represent the process of fabrication rather than the actual making itself. The computer transitions the traditional parameters culminating in the personal cognitive production occurring during this representational stage.

The method of intermediary production imposes and reveals its methodology in the finality of *re*-production. The parameters of representation convey a depiction simultaneously resulting from, and emerging out of, the methods of conceptual process as the "how" inherently influences the "what." The systemization of methodological investigation imposes a distinct effect upon the product *of* that system. The operator employs the rules to define their liberation. The ability to work within a system is the foundation of all social interactions. Rules establish boundaries. Dave Hickey illuminates the ability for rules to liberate the individual by sustaining the parameters within which one must re-invent oneself to advance the group. Hickey proclaims that basketball, as the most democratic of all sports represents the quintessential framework for liberation. Dr. J and his under-over behind the back shot, allowed for a deflecting re-invention of the sport of basketball[6]. An understanding of the system allows the parameters to define a way to overcome their limitations by turning back into the fold to use the system against, and ultimately for, itself. Digital technologies provide the new moves in architecture.

The output of physical action causes a physical reaction isolating and depositing through systems of language and information a detached conveyance of a virtually occupyable satellite of the mind. The informational positioning and fracturing is amebic[7] in its cellular reproduction: able to duplicate, persevere and amplify its conceptualization infinitely into the environment like the foundational principles of contemporary pop culture founded in serial image production and information dispersions via the global informational web of the Internet. The serial dispensation of satellite cognition allows for the unintentional and ultimately chaos theory based informational interaction that spasmodically invades the perceptual realm. The digital realm orchestrates an archive of information that systematically reproduces outside of the formal system of fabricated presence.

The machine as a vehicle of exploration self-maps the internal workings of the mind for external consideration. Isolation recognizes structural formulation and perceptory consideration allowing for the manipulation of the systematized digital media to redirect the destination. This innate process is employed as a liberative means. Robin Evans in his essay "Translation from Drawing to Building[8]" addresses the removal of the architect from the resultant. Unlike the allied disciplines of painting or sculpture, architecture employs intermediate means to accomplish fabrication resulting in reliance upon a language of production that conveys the conceptual intention and material processes to *collaboratively* produce a "construction." The architect operates in a borderland realm distinctly "between" the individual and the collective where the architectural remains removed, placing its production in the language of investigation and graphic communication. The syntax as the final element, uniquely defines its own presence, suggestive and dependent upon the implications of its representation. The resulting object thus imbibes its presence with the methods of its production defined simultaneously by its self-worth and its representative worth.

The employment of digital representation when positioned against more traditional architectural media parallels the artistic debate of photographic production. In all creative disciplines, an exact understanding of the media governs the production of the output. The collaboration of the conceptual intention with the technical processes is

represented in a unique method of disciplinary output. Painting relies upon the two-dimensional manipulation of surface, while sculpture a three dimensional manipulation of collaged materials; each directly engaged in the process of fabrication. The conceptual instigator simultaneously assumes responsibility for the physical realm. The inherent qualities, capabilities and limitations of the manipulation permit the process to inform the output of production. A Jackson Pollack painting synthesizes the method of Pollack's physical dance and the drip of paint running down his hand with a conceptual and instinctually visceral reaction to directly and simultaneously determine the resultant[9]. Photography transitions production to a mediated *multi-staged* system orchestrated through the mechanical lens of the camera. The removal from immediate production culminates in a detached resultant as the photographic production process is separated into two distinct phases, each technologically dependent upon a mechanized system. The additive factor of this multi-tiered process is the insertion of time. The immediacy of action to reaction is extended through the complexity of the process innately fracturing the resultant from the instance of inception and occurrence. The fissure of time creates a relational distance of occupyable terrain. The architect similarly phases his role from active production to passive orchestration with an exaggerated fissure extending the sequential distance through the scope and magnitude innate to the scale of a constructed undertaking. Digital media allows for the simultaneous fabrication of the process and the resultant through the model of the cyborg.[10]

The body, as a sensorial environmental mediator displaces the mind from reality. Limited by ten digits and a prescribed language,[11] the fissure between cognitive action and physical reaction is innate. The instinctual bridges as habit and experience synthesize an immediate hybrid of action and reaction. Digital technology exaggerates this relationship through a virtual realm indebted to the rationality of its system maintaining similar semiotic delineations to contemporary linguistics where meaning derives from a contextual stance of relation.

Digital space is dependent upon this association, compounded by interface resulting in a variant system between the pro-active flow of the mind and the passive stasis of the machine. The resulting lag, maintaining a detached system of communication, provides distinct methods of systemized information conveyance inherently influencing the product as illustrated by the recent flourish of digital constructs as: blobs, wiggles, folds and distortions. The traditional constraints of rectilinear standardization that derive from the fabrication and rationality of the Miesian box are being replaced with an increasingly complex rationality. The key variant in the new digital method is the separation of influence from the conceptualization of production to the conceptualization of cognitive production. The tangible tactility of the result removes itself from digital methodologies, as the product becomes information itself.

The removal of the object from a direct mediation becomes fundamental to the manipulation. The veil of the operating system, that conceptually includes the rigidity of hardware and software interface systems alike, becomes *the* link that maps the ability for the transformation from input to output. This barrier, which governs techno-phobia in its discontinuity with individual intuition, establishes the regulatory rules of operation forcing translation of the personal methods of the individual.[12] Digital media celebrates its communicability and rationalizes its employment transcending any complexity of process, by the overwhelming sophistication of its resultant.

The result of digital operation is a conceptualization of a fissure that no longer permits the maintenance of the "individual" forum for representation and design process, as uniqueness must succumb to the rules of the system in order to mediate its constraints. It is however these rules that represent themselves in all aspects of architectural design to provide the action to which one can re-act. Capabilities have never been limited by constraint, simply re-directed and amplified in consideration to accomplish the desired resultant.

The digital realm, like Dave Hickey's description of the game of basketball, allows for the individual to interpret the rules to manipulate their operation. The relationship of accomplishment to a frame of reference establishes the greatness of its achievement. Everest represents a mountaineering feat in its scalar comparison with other global terrains. It is not *a* mountain but *the* mountain as one comprehends the extreme limitations of temperature, air quality and weather. Digital representation transitions the physical burden of manual abilities to the cognitive realm. No longer limited by the traditional constraints of representation, the machine liberates the mind.

The synthesized production of architecture within the digital realm forces interface methodology to become a hybrid: the ***cyborg***. The synthetic model operates by simultaneously linking the manual nature of production with the conceptual foundations of intention by relying upon instinct:[13] the uncontrollable intellectual realm that governs our subconscious presence. Habit and experience imbibe the digital mediator with instinctual responsibility in the method of production.

The balance of the system of production and the product itself emerges out of the individual cyborgenic model. Chuck Yeager, in his treatise on dog fighting[14], speaks about the relationship between man and machine. The cyborg is the hybrid, created when man enters into a union of both body and mind with the intricate technologies of the vastly complicated airplane. The necessity is a simultaneity that allows for the individual to push ones anatomy and the machine's engineering to the maximum. At this extreme edge, the two become one as the cognitive shuts down defaulting to the instinctual. The merger allows for the individual to stop flying the plane and rather "fly the bullet.[15]" This synthesis is essential in the foundations of digital interface. Conception emerges out of a system unseen to the mind (operator) and hybridized by the limits and extremities of technology.

The introduction of the fourth dimension is the revolutionary foundation of cyborgenic production. Time, as the mediating factor of physical conceptualization, is ever accelerating. Speed as a relationship of time to space increases both the physical as well as cognitive realms of responsibility. Like the exaggerated reality of the photographic process, architecture succumbs to a removal of inception from resultant. Digital media remains employed by a pedestrian mentality in contemporary architectural realms. The capabilities have simply been employed to accelerate the traditional methodologies of architectural conceptualization and production denying the innate opportunities presented by the digital realm. The phased timeframe of production allows for the digital collapse of traditional boundaries.

Though still a technological infant, computer prototyping[16] represents the direct relationship of digital technology in linking the mind to product. The resulting transformation shifts the framework of the architectural profession as a service industry by inserting an actual methodology of craft that provides simultaneous responsibility for the production of architectural space in *both* a physical *and* representative way. The machine links the traditional means of symbolic illustration to a physical and literal end unleashing the parameters of material and form.

Current fabrication abilities are in transition as innovation and economics constantly evolve the process, thus the immediate impact is witnessed by digital media's geometric generative capabilities. The traditional perspectival and formal manipulations that can conventionally be undertaken by Renaissance derived construction methods of shallow projected space are accelerated through the digital media's mathematical efficiency. The result is not the illustration of new forms, simply an acceleration of their generation and liberation from the traditional parameters of operation. The introduction of the systematized mediator into the design process allows for transition through working within the system. The synthesis of man and media allows for an instinctual hybridization of thought and action to fabricate digital architectural spaces. Digital technologies have unique parameters that liberate through their fundamental conceptualization generating a new formal realm of blobs, wiggles, folds and distortions, dealing innately with issues of

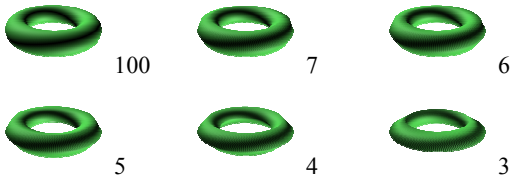
representation. Focusing on the transition of design conceptualization, issues of scale, geometry, form, materiality, view, light and sequence each transition their parameters of consideration. Digital media re-interprets, and advances a new perceptual system of organization and understanding.

Scale

Representation is no longer a proportional scaling of the resultant, but a literally dimensioned fabrication.[17] Digital media, by employing a direct 1:1 scale provides a dimensional authority that imbibes the process of fabrication with a monumental scale. The transition implies new parameters of perception and responsibility.[18] The increased scale expands the production in intensity and precision expanding the microscopic and macroscopic views to an infinite threshold. The expansion of conceptual consideration now includes the molecular realm of materiality and the object quality of the *entire* composition. The simultaneity of scale possible to occur within the same composition assimilates the perceptory presence of the ultimate resolution of fabricated product. The new scale positions the process closer to the product

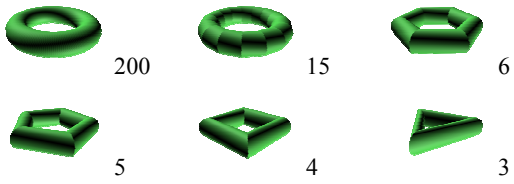
Geometry - The conceptualization of digital construction innately emerges out of the subscribed organization of the operating system founded in the mathematical constructs of Euclidean space. Digital technologies advance the parameters of perception by rapidly extending visual conceptualization in three-dimensional space. The formulation of constructed elements is dependent upon their geometric origins thus production of form is digitally definable through two primary methods: the construction of standardized primary geometric forms, and the planar assembly of elements.[19] The systems of union can be defined as either additive (union) or subtractive (subtract) in the development of producing a language of totality out of the distinct building blocks. The componential construction thus demands an elemental tectonic understanding of the structuring primitives and their innate properties. The variations of geometric application reveal themselves through a comparative presentation. The following examples illustrate the subtleties of a singular factorial variation's formal effect. The first series represents the variation in the number of sides of a torus. The resulting formal change is evident in the drastic alteration along the section as the perceived torus curvature flattens to a "flying saucer-esque" diskobolos.

iterations of sides



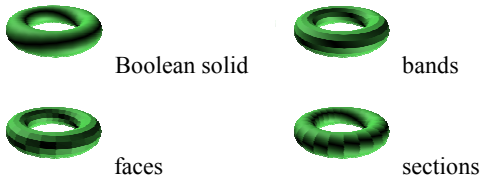
Similar variation occurs when the alteration operates on the segments, changing the parameters of curvature around the circle. The geometric alteration transitions torus to hexagon, hexagon to square and square to triangle changing all visual definition.

iterations of segments



Other methodic realms of production include: surface mesh, solid shape insertion, face variation, banded layers and segmental accumulation. Each of these methods allows infinite alterable delineations within its variable parameters, but when employed in unison establish a matrix of calculable shape opportunities.

alterations



Form - The conceptual frameworks that define geometry thus define form. The production of shapes occur in either: a two-dimensional mode purely

fabricated by segments,[20] or in a two-dimensional closed mode that creates a plane (geometric surface with no thickness which allow for a transmutability to the three-dimensional)[21], or a three-dimensional form allowing for multi-faceted dimensional design.[22] These disparate modes work in conjunction with one another while distinctly segregating their presence. Each system of operation declares its autobiographical rules of engagement permitting variable resultants dependent upon the distinction of their methods. The formal generation subscribes to a digitally internalized cyborgenic relationship of generative cognitive systems with technical fabrication abilities. The geometric parameters[23] dominate the variables to generate the increased catalogue of formal opportunity.

Materiality + Light - Material application allows the textured relationship of formal spaces. While digital media's capability for simulation is traditionally employed, the media's greater potential lies in the visual documentation of the conceptual intention. A relative scale of coloration, texture and gradation allow an investigation of material application and adjacency. Virtual forms fabricate and represent themselves with identical response to biological optics.[24] Employing the construction principles of projected light and its transitional movement provides the simulation and potential orchestration of both natural and artificial conditioning. The ability to employ complex gradation increases the approximation of specificity in *effectual*[25] simulation. The expansion of the parameters of investigation liberates the mode of tactile operation linking digital technologies closer to physical fabrication.

View - The transition of digital positioning from tangible architecture allowing for physical inhabitation, to the virtual realm, visually occupiable, establishes a removed filter mediated by the method of projective construction. The point of view of the picture plane is the greatest liberative tool of digital media. Transforming the vantage of investigation from the traditional orthographically projected view to an internalized vista occupying a position within the composition. The resulting perspectival vantage, (in conjunction with the animated sequence), provides a fragmented and receding view duplicating the interpretive methodology of the mechanized camera lens. The accelerated speed of geometric calculation inherently capable through digital media allows the practical employment of the constructed sequence for investigation. The projected view simultaneously defines the vantage with the composition establishing a unique threshold inserted into the design process previously held by occupation of the finalized, constructed product.

Sequence - Time animation - Motion - The organizational axes rely upon the legacy of the x, y and z planes, distinctly charted points and linking equations formulaically and geometrically defining perimeters. Time, when quantifiably accommodated as the fourth dimension, enters as a disjunctive devise that accordingly reframes the previous boundaries of visualization. In 1920, photo-chemist Louis Lumiere published an account of a new method for still photography termed "photo-stereo-synthese.[26]" Employing this method, Lumiere:

> "subjected the camera lens and photographic plate to proportional, axial movement around the profilmic object, (a man's head) creating photographs in which only a specified plane within the space of the object remains in fixed relation to the plate during a single exposure. This fixed plane of the object registers as the sole area of focus on the photographic plate; the remainder of the object appears blurred due to the relative movement of the apparatus. Shifting the apparatus by increment perpendicularly "into" the space of the object with each successive shot, Lumiere exposes a series of plates until every designated plane of the object is recorded. Printing a faint negative from each plate, he then stacks these prints in succession, reconstructing the space of the object in a laminated visual composite. The claim is this composite of images offers a precise geometric register of the contained space of the profilmic object, whereas a single image of the same object shot with a greater depth of field offers only a pictorial sensation of depth.[27]"

The result produced a system that allowed for a physical spatial mapping of a captured image to

phenomenologically approximate its initial state by heightening the parameters of spatial reproduction and mimicry. The digital arena constructs the direct dimension of our perceptual reality. The mediating factor of perceiving this virtual reality (like the mediating ability to inform this virtual reality) becomes the interface.[28] Presently traversed by the two-dimensional surface of the monitor's screen as a conceptual window into another realm. The interface is visually constructed of a conceptual "shallow space" rather than a physical projection of a separated mapping. The additive role of perceptory advancement transforms the methods of visual engagement. The shift in the parameters of perception from traditional methodologies of operation, detaches the viewer from the object by simulating a two-dimensionally perceived sequence. The result is a re-conceptualization of the spaces themselves. Traditional methods of tangible model representation (external object) allow only for experience from a false and ultimately unoccupyable vista. Architecture is never experienced in a simultaneous autonomous realm, the architectural promenade allows for the orchestrated sequential experience of compositional fragments. Digital media produces an exploratory method for approaching the sequence directly mapping its consideration into the design process.

Each of these resultants of contemporary digital media is defined by the interface. The accentuation of the two-dimensional visual attachment combined with the accelerated calculation of geometric equations results in an exaggerated hybrid condition of existing methods restructured *amidst* the new systems and *by* the new systems governing the methods of input and orchestrating the methods of working within the media. The factors governing limitations are found entirely within the methods of the operating system expressing output impossible without digital technology. The transition of reactionary time shatters previous limitations of conceptualization by expanding their parameters. Calculated precision previously preventing such investigations liberates the constraints and dependencies of individual responsibility. The culpable realm demands a new method, mentality and product. Digital media has re-invented the standards by accelerating the rules.

Endnotes

[1] Kostof, Spiro. History of Architecture: Settings and Rituals. Oxford University Press: New York. 1995. p 727.

[2] Quain, John R. "Hacker Trackers" *Popular Science*." February 2001. p. 56-59.

[3] The patriot missile system employs the AN/MPQ-53 radar to combine in a single set the target search, detection track, identification functions and missile tracking, guidance and electronic countermeasures.
Friedman, Colonel Richard S., Bill Gunston, David Hobbs, Lt. Col. David Miller, Doug Richardson and Max Walmer. Advanced Technology Warfare. Harmony Books: New York. 1985.

[4] The legacy of the ***cyborg*** has long since been depicted and evolved in film though characters that are more machine than man or more man that machine including: R2D2 and C3PO from George Lucas' *Star Wars*, *Robocop* and *Terminator* from the self titled multi-series films, #5, "5 is alive" from the *Short Circuit* series, Data from *Star Trek: The Next Generation* television and movie series, and even Tim Burton's dark depiction of *Edward Scissor Hands*; which all subscribe to the componentially constructed individual first illustrated by Mary Shelly's Frankenstein.

[5] Schizophrenia is a mental disorder characterized by indifference, withdrawal, hallucinations, and delusions of persecution and omnipotence, often with unimpaired intelligence.

[6] Hickey, Dave. Air Guitar. Art Issues Press: Los Angeles, California. 1997.

[7] Amebic reproduction, found in single celled animals living in stagnant waters or as a parasite in other animals, multiplies by fission simply breaking itself apart to produce an identical other.

[8] Evans, Robin. Translations from Drawing to Building and Other Essays. MIT Press: Cambridge, Massachusetts. 1997.

[9] Pollack's action paintings of his latter years making him iconic as a modern abstract expressionist.

[10] The technical "how-to" of this process will be more elaborately discussed later when the specifics of the new method are outlined.

[11] linguistic approach encompassing over 3,000 various global dialects and their fracturing based on the secondary system of the alphabet

[12] The foundation of translation is change - not change that emerges in the resultant when cognitive intention is maintained, simply change that emerges in the methodology of representation and expression altering personal physicality and rationality to subscribe to the systematized standardization dictated by the linear rationality of a code capability.

[13] The traditional tasks of breathing and the consistent electrical impulses that maintain the heartbeat, circulatory system and thus life.

[14] General Chuck Yeager. "How to Win an Dog Fight." *Men's Health*. November 1994.

[15] Kwinter, Sanford. "Flying the Bullet or When Did the Future Begin?" Rice University Press: Houston, Texas. 1993.

[16] Via milling machines, three-dimensional scanners, laser cutters and Z form three dimensional printers to name a few

[17] Photoshop, AutoCAD, Form Z, Rhino, Alias, MicroStation and other drafting, graphic and modeling programs each subscribe to a literal scaling of both dimension and resolution. The proportional relationship of the two gradients, collaborate to orchestrate the retinal perceptional of our biological limitations for cognitive digestion.

[18] despite the proportional vistas monitors offer for mediation

[19] Computer-aided modeling programs typically employ either surface construction (volume) or Boolean solids (mass) in the construction of three-dimensional entities.

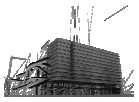
[20] The unique maintenance of a modified version of the traditional two-dimensional realm of representation.

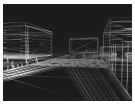
[21] An intermediary stage of the system still in the two-dimensional realm, but closed and thus poised for conversion (extrusion) to the digitally three-dimensional.

[22] The new virtual realm of three-dimensional fabrication.

[23] The formal principles were previously touched upon during the discussion of virtual geometry. The innate attachment maintained in the physical world is only amplified by the "digital."

[24] The exception to the understanding of three-dimensionality as a gradient and cognitive reference to light is the wireframe. Its artificial structural presence illustrates the digital vista of shape understand but allows for an abstract methodology of graphic interpretation.





The eye is able to traverse the solid surfaces while cognitively maintaining their separating presence. Thus the cubist collage is perspectivally collapsed to maintain foreground, middle ground and background simultaneously while employing only lines to depict a typically planar system of recognition.

[25] It is key to note that digital media employed as a simulation of reality to provide a snapshot of reality denies the innate potentials of its innovations. The subjection of digital media to produce a true to life condition denies the conceptual potentials of the new arena.

[26] Compte Rendu des Seances de l'Acadamie des Sciences 171. 1920.

[27] Cartwright, Lisa and Brian Goldfarb. "Radiography, Cinematography and the Decline of the Lens." from Jonathan Crary and Sanford Kwinter. Incorporations. Zone Books: New York. 1992.

[28] Engeli, Maia. Digital Stories: The Poetics of Communication. Birkhauser: Boston, Massachusetts. 1999.

Research Ideologies, Information, and Moral Dilemmas

Frances Downing
Associate Professor
Department of Architecture
Texas A&M University
College Station, TX
77843-3137

fdowning@archone.tamu.edu

Research Ideologies, Information, and Moral Dilemmas

Is there a "shape" to information? I have been asking this question of my latest Ph.D. class in theory. To produce a "knowledge-based design" architecture practice and/or teaching we have to process information in a way that we find useful, being a generally pragmatic group. Information, however, is a tricky subject. For instance, is the "shape" of information (mathematical equations, matrices, shape grammars, typologies, taxonomies, hypothesis, content analysis, allegories…etc) dictated by "how" you ask a question much less "what" is the question you are asking? Ph.D. students in architecture struggle, in their first semester and beyond, with what question they are asking and what methodology they should use to "find out" the information needed to answer the question.

To define "information" philosophically I would have to follow some fairly complex and dry interpretations of Hume, Pierce, Lewis, and a bunch of other white Western philosophers. It would probably be simpler to leave the definition of information to the dictionary: "the communication of knowledge or 'news' of some fact or occurrence; the act of telling or the fact of being told something."[i] This last part of the definition of information is particularly relevant, as it seems to tell you that you should go chase your tail. I am not a philosopher, but the questions that students ask can often be traced back to what I would call a "research ideology." I define research ideology as a consistent logic between the relevancy of the question, it's premise, it's assumptions, the method used to collect data, the practice of analysis/interpretation (as form), and the conclusions drawn (as information).

Unfortunately Western philosophy has outlined a deep divide between how one can approach research and the bridges that people have tried to build have not always held structurally (pun intended). John Collier[ii] defines the major "characteristics of modern thought is the pervading tension between the object and the subjective, the universal and the particular, the eternal and the temporal, the global and the local, and the ultimate and the immediate." I do not particularly want to debate that the two sides exist; they are simply conundrums of thought established early, generally produced by early Greek thinkers. In the class I teach I think it is important for students to understand that "picking" a methodology is a more serious act than their pragmatic souls would like to indulge. I think it is important for a student who earns a doctor of philosophy to have some idea of what philosophy means, and how it leads to particular methodologies, and perhaps in this case, the shape of information.

The "great divide" in Western philosophy has left me with

students who take up positions near the ends of the divide, and those who try to span it in some way (usually by addition or invention). The "divide," as a term, seemed too permanent or unforgiving to me so I have defined it as a series of continuums. For this class I defined two distinct but interrelated axes that cleave Western thought into four somewhat defined groups. The first axis runs between passive and active, the second runs between individual and community. The axis between passive and active is marked at the point where theories of evolution (Spencer and Darwin) were beginning to "adjust" worldviews from one that identifies individuals, communities, or the world as relatively passive receptacles of data to individuals, communities, or worlds that are creative expressive, dynamic, and constantly in flux.

The second axis between individual and community is defined by the crisis of "self" in European Philosophy of the 1700's that partly spilled over into the establishment of some American pragmatists. The most significant issue for this group of Ph.D. students was the unit of research. On one hand the unit of research moves from objects or structures to activities, on the other hand the unit of research moves from individual objects to community structure. This is really a three-dimensional structure, if time was taken as the third axis (see illustration 1).

I have lately organized my class around debates—true debates, three students for each side—who structure an argument that is basic to research. The question, in each case, possesses the basic subject/object problem in Western philosophy. The first question was: Do inherently structural or organic universal and absolute laws exist for how the world domain is arranged, or is the social/physical world/universe dynamic and constantly changing (See Illustration 2).

The debate went well, we had no resolution. We had two sides that argued long enough to sort out a couple of things. The people who like to measure phenomena, occurrences, or ideas and who are comfortable with predictability are attracted to universal, or at the least *probably* universal, laws. Although three students argued valiantly to defend a completely positivist view of inevitable and knowable cause and effect relationships, they were unable to convince any of us to stand without probability as a reliable alternative. The other three students noted that the theory of evolution and the theory of complexity made it impossible to have universal laws. Even at the two ends of scale, from the universe to subatomic particles, change existed but was often too slow or too fast to be detected by our tools for measuring. Besides, how can you possibly measure significant phenomena, occurrences, or ideas? These three students argued vigorously that there were no absolutes other than change. Although no one was willing to plunge over this edge completely, there were

those who thought the idea of "measuring," then reliably "predicting," was suspect "knowledge." At the end of this debate everyone sort-of huddled in the middle by admitting that we rely on measurements because we "believe" it is a good foundation for some kinds of information. But for other kinds of information, like how light effects the emotions of people in a Buddhist Temple, how do you "measure" these things with a traditional, quasi-empirical method? What kind of information do you need to make a significant effort to "know" *something* about intangible phenomena, occurrences, or ideas?

The following two weeks brought the next debate. The question posed was: can you build from a foundation of separate, independent data modules a theory for how the world domain functions, or, must you understand how a whole, indivisible domain functions in order to distinguish its interwoven, concurrent parts (See illustration 3).

The debate went well, we had no resolution. The two ends of the continuum were debated with physical props, illustrative diagrams and vigorous arm-waving. Again, although the teams of three were committed to either parts or wholes, no one was convinced to stand only at one end. Did one need a "foundation" of fact to "know" anything or could one pursue a more "coherent" systematic, situational "way of knowing." One model promotes a foundation from which a string of logic from premise to conclusion is built. The other end of the continuum promotes an interwoven, three-dimensional web where the interior of the web contains the most logically connected beliefs and near the exterior the web begins to have inconsistencies. Was there a middle ground where a composition of logic and belief could meet? Are there different kinds of information in our lives?

At this point we were starting to discover that it was difficult for some students (and professors) to separate their research question from the life they lived day by day. Others had no problem with different structures for different understandings ("I can measure phenomena, occurrences, or ideas effectively when they are dissected from the 'noise' of the rest of the world, then I can go home at night a be a loving mother/father by helping my child to understand faith"). The students who could separate usually fell somewhere in the empirical/ pragmatist camps, the students who could not fell somewhere into naturalistic inquiry or beyond (I dread trying to explain phenomenology, in fact, it can not be explained but only understood?). Anyway, things were just getting interesting.

The following two weeks brought the next debate where the question of determinism and indeterminism was addressed in more detail. We asked the students to think about whether they believed that there is a linear and direct connection between entities—a compelling relationship of cause and

effect, or, if they believed that all connections are complexly woven with enough fragmentation to suggest unpredictability and chance (See illustration 4)?

The debate went well, we had no resolution. The arm-waving continued as one side argued inclusiveness with active construction on the part of the inquirer. One could not predict the future of anything because we could not tease-out the interfering variables—including the inquirer. This proved to be a convincing argument until we were faced with the "laws" of physics. Perhaps we could not know things with absolute predictability, but we could come to that precipice with some conviction in certain disciplines. This was interesting as the matter of the "scale" of the inquiry, or the "unit" of inquiry, began to clarify. It seemed to me that students who felt they could measure things (events or objects) like the erosion of an adobe wall or the energy lost through a certain wall type, had either physical devices or physical laws through which they could proceed. This is somewhat true of people interested in some kind of communal action if measurable (surveys or patterns of behavior). At the biologic scale, however, individuals or individual pieces of the puzzle become more dynamic and difficult to "scientifically" measure with the tools we have at our disposal. The realization that the scale or unit of inquiry was an important determinate of what information would "look-like" was the outcome of this debate.

During the following two weeks another question was posed. This question had to do with where the inquirer "stands" in relation to the information they pursue. At one end of the continuum there are those who believe they stand independent and external to the entities and occurrences they study—an objective observer of the "other." At the opposite end stand those researchers who believe the world to be complex and sticky. For these students the connection between the knower and the known are dependent. One cannot eliminate subjective complicity in whatever inquiry is afoot. The knower and the known permeate each other.

The debate went well, we had no resolution. Students seemed to be more confident at this point that they would "never figure out anything." I commiserated with them, telling them of my own difficulties of working out how the world worked. The debate again turned on whether the world was seen as empirically knowable, or biologically messy. How long could one hold the world "in place" so that one could contemplate its objects or events? Actually, the term "event" introduces a notion of time that is difficult to discard from objectivity. Events imply that things are always changing, either very, very slowly over time or so quickly that we cannot discern or conceptualize them. Objects that were considered real and outside our bodies were

changing, but most were eroding so slowly that it might prove irrelevant to an investigation.

Students had to begin to come to some conclusion about the scale of their inquiry or, perhaps, what was the unit of inquiry. They also needed to decide to what level the world, including ourselves, is passive, or to what level it is active. Then they had to decide how they stood in relation to their inquiry—outside or inside, or somewhere on the edge. Many of the students were trying to take "middle" positions—finding themselves somewhere "between" ism's and ideologies. Others separated their experience in research from their experience in life. A few may have tried to hold to a strict ideology, but I found this rare. Our intent was to confuse them initially, then slowly build the ideologies and questions surrounding each continuum, and finally to have them clarify their own positions as researchers. Many stay confused until they see the end of the semester coming—they become recognizably pragmatic. A few remain befuddled and sometimes distraught. But most students find themselves somewhere in the puzzle of research ideologies.

The final debate was to be about "information" and its "shape." With each research ideology that we covered there were examples of the methodology and outcome. I was unsure how to pursue a continuum relating to information. Initially, I thought that the continuum about information should be from simple to complex. On one end, the formulation of universal laws at the core of any explanation of data is what is sought. The order can be quantifiable, essential, or foundational. On the other end one can understand the data to be intricately woven, nonlinear, and labyrinthic in nature. We did read and discuss issues of information but I felt less sure, in this case, how to proceed. Perhaps the continuum I began to develop was not yet the right one or a continuum is not appropriate here.

Initially I had thought of this part of the class as addressing the nature of "order." The simple end would encompass essential, linear, sequential, typological, indexed, or ranked information. The other end of the continuum would be a complex arrangement of information—non linear, tumultuous, intricate, and arrhythmic. Between would be systematic, taxonometric, and integrated arrangements of information. This construction has something to do with static and active views of the world. If you stood on one side the information would be simple and elegant; if you stood somewhere in the middle the information would be actively manipulated but would also display order; at the other end the information could be seemingly overwhelming but would have an overall pattern that could be discerned (See illustration 5).

I believe that it is a part of human, collective nature that requires us to construct order. I do not know whether this desire is biological or mechanical. John Collier claims that our collective nature "requires that we find some way

to live with the tensions" of our rational, social condition. Other authors, like Gerald Edelman in *Bright Air, Brilliant Fire*[iii], suggest that while the theories in physics provide the necessary bases for biology, it is not the concern of physics to deal with biological structures, processes, or principles. He calls this kind of transfer a "category error." Order, to this neoDarwinist, consists of a large dose of "free-will" with the introduction of environmental data that are meaningless if we do not understand "intentionality" on the part of the individual. So as a community we may seek order differently than the biologically based personally aware individual.

Students, and professors, may be making a categorical error when they try to understand the world domain utilizing one worldview for all scales of macro and micro conditions. But this seems to be the core of Western Philosophy and Science, to come to one understanding or order. Not only do I slip around and change research ideologies depending on the question, I also am looking to produce different kinds of information at different scales of a research unit. Consistency across units of research and scales of inquiry seems to be a very elusive state. Most of the students display a "range" through stepping from one ideology to the next, adding ideologies to each other, or bridging and sometimes inventing research ideologies. Looking for one answer, or one kind of information seems unnecessarily dogmatic. Instead I find that there is a kind of Escheric continuum where information may simply fold into the next "scale." However, Collier notes that "A satisfactory science should be able to account for spatio-temporally extended dynamically organized autonomous entities such as ourselves…a purely external perspective has trouble reconciling extended, self organizing particulars with its universal laws[iv]." Collier concludes that beginning with the advent of systems theory—that complexity theory has produced a more holistic approach to phenomena. In complexity theory one can determine the shape of the external or structural system, sifting its non-random behavior to time and measurement. At the same time, the internal perspective is more autonomous and adaptive, unfettered by absolutes and able to describe our social systems.

The students of research in architecture have a continuous struggle before them that is real, complex, and ethical. To order is a strong desire in these students—they want answers. When I was a student, it was understood that the world domain was explained through quasi-empirical cause and effect relationships. With time, my view has "moved" around the map of explanation and understanding. The advice that I now give to these students is that perhaps they need to identify the "unit" and "scale" of research before they choose a method of inquiry and its ideological baggage. This allows for adjustment, depending upon a change in the focus of their research. I find, by

taking this position and structuring the class through debates, that the class members have generated a kind of positive tolerance of different "ways" of structuring and pursuing research and the varied physical outcomes of information. My desire is that this kind of exchange creates a more complex and satisfactory exchange within the group and between groups within the design and research community of the College. These students tend to stay in touch with each other and become voluntary critics of each others work. I believe the course content has ferreted out the shape of information as it relates to ideologies, but conclusions of good fit between research design, ideologies, personal beliefs, and professional inquiry are still debated among the students.

---

[i] Oxford English Dictionary (the 5th meaning of the verb "information")

[ii] Collier, John "Emergence of the Internal Perspective in Western Science," *Contemporary Philosophy. 24-11:* 355-362.

[iii] Edelman, Gerald. *Bright Air, Brilliant Fire*. Basic Books: New York, 1992.

[iv] Collier, *op cit, 356.*

1) Illustration of the intersection of axis.

	PASSIVE	**ACTIVE**
INDIVIDUAL	DESCARTES (1596-1650) • Rationality = **introspective reflection.** LOCKE (1632-1704) • Rationality + Causality = **observation** of world. HUME (1711-1776) • Rationality KANT (1724-1808) • **Categories** = **structure** of thought. FREGE (1848-1925) • **Logic** & the **structure** of language. BERGSON (1850-1941) • **Inference** & intuition from our own experience.	ROUSSEAU (1712-1778) • Introspection + Freedom = **expression**. KANT (1724-1808) • **Construction** of world is necessary SCHILLER (1759-1805) • Individual **expression** of self as universal. FICHTE (1762-1814) • Individual **participates** in & **uses** world. JAMES (1842-1910) • Humans **interact** with and **control** the world. BRENTANO (1838-1917) • Consciousness is **directed**, **intentional**. DEWEY (1859-1952) • Individual, **creative** intelligence.
	UNIT OF RESEARCH = Individual objects in the world **through observation, reflection, and logic.**	**UNIT OF RESEARCH = Individual human activity** in the world **through experience, construction, and expression.**
COMMUNITY	DARWIN (1809-1882) • Natural selection = **induct/deduct observation.** SPENCER (1820-1903) • **Evolution**, the product of which is **increasing complexity**.	SCHILLER (1759-1805) • Self to be **integrated** with culture and politics. SCHELLING (1775 -1854) • Humans **grow** and **develop** in a living universe. HEGEL (1770-1831) • Spirit **merges dialectics** via culture & language. DILTHY (1833-1911) • Hermaneutic **interpretation** of human experience.
	UNIT OF RESEARCH = Community structure as an object in the world **through observation and reflection.**	**UNIT OF RESEARCH = Community activity through dialectics, development, and integration.**

2) Illustration of Static/Dynamic Continuum.

STATIC	.....	.....	.....	**DYNAMIC**
• Pertaining to forces in equilibrium, or to bodies at rest. • Inherently structural or organic as opposed to functional **Universals are absolutes that exist in forms, laws, or structure.**	Predictable Controlled Correlative Correspondence Distinction Contrasting	Constructed Reciprocal Relative Communion Complementary Mutual	Interrelated Interconnected Interactive Coherence Diverse Variable	• A force producing motion. • Potent, vigorous, pluralistic, and varied. **There are no absolutes; change is the only attribute of the world that is constantly present.**

3) Illustration of Part/Whole continuum.

PART				**WHOLE**
Individual Discrete Apart from Self vs. Nonself Independent Autonomous	Ensemble Assemble Juxtapose	Interaction Interwoven Concurrent Composition	Woven Collective Structured Re-Structured	Indivisible Total Entire Complete
The inquirer gains objectivity by abstracting from all perspectives, and ac-cumulating facts.				The whole picture is an image created morphogenetically from multiple perspectives.

4) Illustration of Independent/Dependent continuum.

INDEPENDENT				**DEPENDENT**
Objective Extrinsic External Isolated Separate	Accompanied Accommodated Detached	Constructed Relative	Connected Comparative Associated	Subjective Contingent Sustained Correlated Interrelated

5) Illustration of Simple/Complex continuum.

SIMPLE				**COMPLEX**
Linear, causal links. Sequential Typological Ranked Indexed Reductive	Hierarchical Categorical Continuity Probable Feedback	Taxonomy Interconnected Bound Systemic Patterned	Irregular Complicated Involved Integrated	Nonlinear Tumultuous Intricate Labyrinth Descriptive
Abstract out for intense study one or a few elements while holding everything else constant, that is, known parts can predict unknown reality.	The principle of hierarchy is that there is an inherent order in nature.		It is impossible to separate a thing from its interactive environment, diversity and interactivity are characteristic of reality.	**If** there are orders, many of them exist side by sided heterarchically.

Rituals and Bodies in Spatial Reconstruction of Past

Reena Tiwari, Curtin University

Introduction

The increasing displacements of populations between nations, and the changing distributions of racial and ethnic populations within nations have created a search for a new identity. Old maps of identity- national, cultural and individual are being re-drawn. Soja in 'Postmodern Geographies' writes about Los Angeles being a theme park of World Space, "There is a Boston in Los Angeles, a Lower Manhattan and a South Bronx, a Sao Paulo and a Singapore."(Soja, 1989). This seems to be a result of nostalgia arising from estrangement or alienation.

If we look at the phenomenon of the search of a lost identity, recreation of the past, reconstruction of a recognizable environment based on a nostalgic past, we find that it is not true for the contemporary city alone. Being nostalgic is a part of human nature and hence we find its reflection spatially, in some of our very old cities too. Varanasi in India, a city two thousand five hundred years old, is such an example. Here residents construct their Lord's city every year, based on a 16th century text, through rituals. During the performance residents in a liminal phase, inhabit a reconstructed environment, where they remake their identities and find linkages with their past. This environment becomes a ground where the city of the past and present coincide. It becomes a metaphor for the textual city.

Contrary to this we evidence a more politically driven nostalgia leading towards a borrowing of image driven and traditional architectural forms. In this process of 're-construction of past', the focus is totally on visual surface, creating instant urban-scapes lacking in depth, memory and ritual. Pronounced visual character is an important aspect of such spaces. Their design relies on the visibility of people and things and whatever is contained in them. "We build on the basis of papers and plans. We buy on the basis of images. Sight and seeing, which in western tradition once epitomized intelligibility, have turned into a trap: the means whereby, in social space, diversity maybe simulated"(Lefebvre, 1991, p. 75).

Ritualized spaces, on the other hand, do not rely solely on vision. Here all senses are kept alive by total bodily participation. Ritual acts as a mediator in linking the body to the space not only physically but also at a metaphysical level. Because the space acquires a meaning due to the rituals, it is not the things which can be only seen in the space that matter, but what that space represents becomes crucial.

This paper takes up an urban space in Varanasi and aims to see how the performance/ritual mediates between the textual and the physical space leading to a liminal phase in which the performers start experiencing the past environment.

The physical space is nature, the existing built-up fabric. Textual space is the space as described in the text. Residents have the space imprinted in their minds by reading those texts and hence it can be termed as the space of the mind. Liminality is a phase in the performance, in which the spectators start believing themselves to inhabit the past environment because of the common spatial codes between the physical and textual space. It is here that the city of the past and the present collide.

Textual Space

Ramcharitmanas was composed by Tulsidas in the sixteenth century. Its familiarity to the people of North India equals that of King James version of

the Bible for the English speaking people. *Ramcharitmanas* has acquired its mass audience primarily through oral performance. This includes reciting the text in ceremonies, folk singing and theatrical representations. "It offers a vivid portrait of one community's interaction with its favorite text and the way in which it functions as a flexible and evolving medium for cultural expression"(Lutgendorf, 1991, p. 2).
For Indians, Ramcharitmanas structures the whole sub-continent. The movement of the characters in the episode start from North India, move South reaching Sri Lanka. After defeating the King of Lanka the journey is retraced back North towards the home city Ayodhya. This same movement pattern is followed in Varanasi during a 21-day period, when the whole text is performed. The streets and squares in Varanasi are appropriated to represent different places in India where the sequences of the episode took place. The city is thus mapped by bodily movement.
The paper focuses on one particular performance episode called Bharata Milap, the reunion with Bharata. Lord Rama, victorious over Ravana (King of Lanka) has returned to Ayodhya, his own kingdom after fourteen yeas of exile. He meets his beloved brother Bharata and the brothers embrace. This is one of the big movements of the epic.

Physical Space
Ramlila (the play) is staged in an environment that are spread over distances that make the spectators move from place to place by following Rama in order to attend to his story.
The site of the re-union is a rectangular field containing a huge Tamarind tree (Imli) from which the area Nati Imli gets its name (figure 1). It is a commercial node at a neighborhood level with residences at the top. At one end is a small temple. Just next to it is a stepped platform, which is connected by a paved pathway perhaps a hundred yards long to another stone platform. Every year, before the performance, the platforms are cleaned and white washed, the ground is cleared, and a processional path is laid for the King of Varanasi and his retinue, who approach from one of the side streets.
On the day of the performance the area is barricaded (figure 2). Hundreds of policemen line up to control the crowds, which fill the surrounding streets for lengths in every direction. Roof- tops of the surrounding buildings are leased off before hand and become an area to accommodate the dignitaries and VIPs of the city.

Performance
Based on Lutgendorf's description in 'The Life of a Text' the re-union episode is carried on in sequential scenes.
1. Action: An enormous wooden Palanquin, representing the flying chariot of the defeated king of Lanka, now being utilized by Rama comes in view. It is carried by members of the milkmen community wearing red turbans, and rests on the smaller platform (figure 3).
Soundscape: Chants of "Jai Sri Rama"
2. Action: King of Varanasi seated on an elephant enters along with his retinue. The focus of the crowd shifts towards the king and moves with him as he circumambulates Rama's palanquin and takes his place on one side of the ground (figure 4).
Soundscape: Chants of "Har Har Mahadeva"
3. Bharata and the youngest brother lie prostrate on the higher platform. Rama and his other brother start walking and then break into a trot towards the higher platform (figure 5a).
Soundscape: Ramayanis (people well-versed in Ramcharitmanas) who surround the higher platform start chanting the mantras. Public is absolutely silent in anticipation.
4. Runners, after reaching the higher platform, climb the steps and after lifting up their brothers lying prostrate on the ground, embrace them. Flowers are thrown on them by the people surrounding the platform.
Soundscape: Loud cheering with ringing of bells, gongs and conches (figure 5b).
5. The four brothers form a line, arms around one anothers'waist, face straight and rotate 45 degrees, pause and thus take two complete rounds in eight directions (figure 6).

Soundscape: Acknowledging roar from the appropriate sector.
6. Performers descend and are taken back to the organizing committee's headquarter. Royal elephant moves towards the waiting limousine that takes the king back to his palace (figure 7).

How are ritualized bodies and places produced by this public visitation of Lord Rama?

Liminal phase and the production of ritualized bodies

The red color in the drawings denotes the liminal phase in which the performers and spectators enter in various scenes. In scene one it is just the performers and the people who are carrying them who are within the red blob. Both the performers and the people associated with them are initiated into this phase many days before the actual performance. The boys chosen to play the part of Lords are trained and start living in a separate place away from their homes many days before the performance. During the twenty-one day cycle of Ramlila they are treated as Gods themselves. " They are not merely blank screens on which devotees project the God of their imaginations; 'attributes are of essence here, and the ones that the boys possess – innocence, physical attractiveness, Brahmin hood – are essential ingredients in what they become. The boy possesses by virtue of his attributes, the authority not merely to represent but to become Lord Rama the right moment"(Lutgendorf, 1991).

In the same way there are different roles for different communities in Ramlila. Beautifiers, who supervise the costumes and makeup, represent the community of Gujarati silk merchants of Varanasi and claim their privilege to beautify the 'Lords'. The carriers of the 'flying chariot' are the 'milk-men' of Varanasi and the Ramayanis are the rectors from the text. In scene six nearly all the spectators enter in this liminal phase. The spectator in the first scene becomes a performer in the sixth. Resident of Varanasi transforms into a resident of the 16th Century City of Rama and it is then that the city of the past is recreated. Each body is ritualized where it not only performs a role as a beautifier or a rector or a resident of Rama's city, but also becomes one.

Ritualised space

Centrality becomes a key component that is common to both the spaces as described in Ramcharitmanas (textual space) as well as in Nati Imli (physical space). The two platforms and the runway connecting them are positioned centrally on the north south axis and their very scale enhances the interaction between the performers and the spectators. Performers exit and enter from amongst the spectators. Spectators can touch them, garland them and thus are in a close proximity with them. *This centrality* of axes also promotes a three-dimensional zoning of the space with respect to the status of Varanasi residents. The zones move on from a lower status at the ground level to a higher status on the rooftops. Though opposite to that in the text in which the space is zoned from a higher to a lower status towards the periphery, what matters is the creation of a spatial-social hierarchy, where each person is able to perform as per the zone he/she inhabits. Positioned in the particular zone gives a clue for the bodily action.

The square is not seen in isolation but is linked to various other streets and squares of Varanasi. The narrative is actualized because of the movement from one theatrical environment to the next. Production of a ritualized space thus depends on the codes common in the textual and physical space, which are picked up by the mind during the performance.

Conclusion

"The body believes in what it plays at: it weeps if it mimes grief. It does not represent what it performs, it does not memorize the past, it *enacts* the past, bringing it back to life" (Bourdieu, 1990, p. 73). Scene six becomes a point of convergence of representation, imitation and transformation, not only of the performers' and spectators' bodies but also of the space. There is a collision of the existing or real space, represented and transformed space. "The performance/ritual does not just represent a meaning, but is *lived* through the performer's

experience of her or his body *in place*"(Martin and Kryst, 1998, p. 224). The performance and setting work together to produce ritualized bodies and ritualized spaces. Here meaning is not separate from material. This can not be said about the theme-parks or environments designed on the basis of aesthetics only, where as suggested by Baudrillard, the referents have disappeared completely such that style (or simulacra) has become everything. (Baudrillard, 1975).
Ritual, on the other hand, does not create this difference between signifier and signified, between meaning and material. It brings the body in a close relationship with the space where the "boundaries between self and environment are blurred, allowing one to experience, feel, become, and embody certain qualities of that place"(Martin and Kryst, 1998, p. 225).
According to Lefebvre, "social space can not be reduced to a 'form' imposed upon phenomena. It is revealed only when the mental space becomes indistinguishable from the physical space" (Lefebvre, 1991, p. 27). Thus a focus on to the physical aspects of the space in isolation is not what we aim here. The 're-construction' is complete only when boundaries dissolve between the mental (textual) and physical space and also between the body and space.

References

Soja, Edward. 1989. *Postmodern Geographies: the reassertion of space in critical social theory.* London: Verso.
Lefebvre, Henri. 1991. *The Production of Space*. Oxford: Basil Blackwell.
Lutgendorf, Philip. 1991. *The Life of a Text: performing the Ramcharitmanas of Tulsidas.* Berkley:University of California Press.
Bourdieu, Pierre. 1990. *The Logic of Practice*. Bloomington: Stanford University Press.
Baudrillard, Jean. 1975. *Mirror of Production*. St Louis: Telos Press.
Martin, Angela and Kryst Sandra. 1998. *Encountering Mary: Ritualization and place contagion in postmodernity* in Nast, Heidi and Pile, Steve ed. *Places Through the Body*. London and New York: Routledge.

figure 1

figure 2

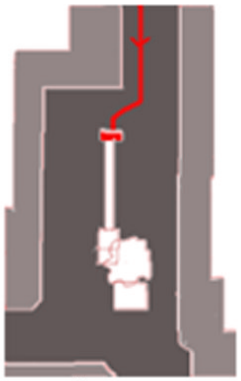


figure 3

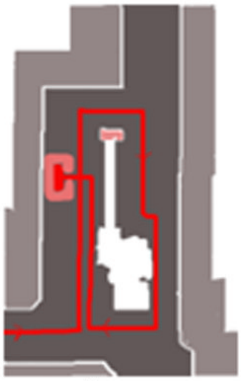


figure 4

figure 5a

figure 5b

figure 6

figure 7

Looking at Place Recording Methods through Web Reports

***Nancy Yen-wen Cheng**, University of Oregon*

ABSTRACT

Since understanding a site is essential for creating appropriate environmental design, knowing the biases of site-recording tools is important. To grasp how recording tools shape what is seen and recorded, we sent students out to their design project locations with sketching tools and cameras. The resulting Web pages were analyzed to find correspondences between tools and captured information. From the analysis and on-site observation, we identify critical aspects of the site recording process, explain what information can be inferred from field reports and show correlations between field tools and the report contents.

Keywords: *media and design process, field studies*

INTRODUCTION: tools for perceiving places

As experiences of natural and urban environments are displaced by technology-mediated experiences, our need to savour and capture authentic moments increases. After sitting in front of a computer screen all day, even a walk through a parking lot is flooded with stimulating kinaesthesia and evocative sensations. Capturing the sensuous experience of place into a tangible form is a challenge made more enticing by new gadgetry. How can we go to a place and fully convey its essence to someone who is not there?

Since this impulse to document place lies with journalists, geographers, urbanists and artists of all types (Hiss, 1990), it is important to distinguish the needs of the environmental designer. Corner (1992) explains that the challenge of representing environments starts from the size, complexity and richness of the physical world and our limited capacity to record, absorb and process the flood of information. We are further challenged by our tendency to reduce the full sensory experience into visual representation.

While each person will approach a place slightly differently depending on what is sought, there are archetypal objectives that shape what will be captured. For example, a tourist looks for beautiful, famous or unusual photo opportunities. An engineer seeks relevant clues about building performance. A real-estate agent searches a property for marketable labels. A designer's interest lies somewhere on the continuum between technical assessment and artistic study, since both quantitative facts and qualitative impressions are sought.

By visiting a site, a designer collects information about physical, social and cultural conditions while perceiving nuances that may shape design direction. Ideally, methods of place recording heighten perceptions and strengthen understanding of a location. But as less efficient processes like sketching give way to a new array of techniques, how can we maintain or enhance the thinking eye? Tools such as video cameras, 3D digitizers, and motion-capture devices automate ways to capture a large amount of information efficiently, but do not guarantee a thoughtful process. Since technology influences how we see, it also shapes what we see and how we think. We need to better understand tool biases so we can target their use in situations where they could increase awareness.

To start understanding the influence of tools on the process of recording environments, this study compares traditional sketching and digital photography. After preliminary observations of the process and how it varies with tool usage, we analyzed site information distilled onto Web pages by looking at what information can be gleaned from tallying imagery. Preliminary correlations between tool use and content are described along with limitations of the results, and suggestions for further study.

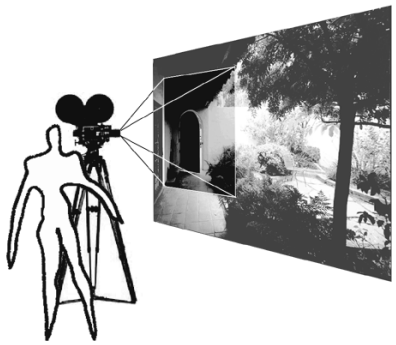


Figure 1. Place recording needs to consider man, media and environment

Rationale for the study

While we can observe qualitative differences in site recording with different tools, it is difficult to track operations and correlate them to thinking. Rather than examining a few designers' process, this study surveyed a greater number of designers' products. While interviews or talk-aloud procedures could give a better understanding of the connection between media process and thinking, they were likely to reveal individual idiosyncrasies.

Instead, site information as published on the Web was examined. Because of its accessibility, if it proved useful others could easily and efficiently peruse many cases. As material selected for further study, the Web pages have a special significance in the site-recording process. Even if the images were chosen with little intention, they acquire importance as a substitute for the site in the subsequent design process. Like an amulet or religious icon, the images hanging over a workspace or posted on one's homepage gain significance after repeated viewings. (Downing 2000) For these reasons, examining the presentation images for ideas on media bias was worth a try.

BACKGROUND:

Phases of site recording

Gathering and presenting place information takes place in the beginning of the design process continuum according to Crowe and Laseau (1984). It makes up part of the Recording and Analysis phases that precede Design. Site recording usually contains some form of 1) Pre-trip preparation, 2) On-site documentation, 3) Post-trip Analysis, 4) Presentation, 5) Reflective use in Design.

Prior to the trip, a designer needs to plan what information will be gathered, how the site will be toured and how team members will be deployed. Equipment and existing documentation needs to be gathered and reviewed so that precious time at the site is used efficiently.

A designer comes to the site with intentions and expectations that may need to be modified at the site. Unfamiliar terrain makes it impossible to fully predict what will be worth recording, so a designer needs an alert eye to catch the unexpected. (Crowe and Laseau, 1984) Particularly for group efforts, a method for organizing and storing ideas, images and video clips is needed. Information needs to be organized in a retrievable form with enough identification & cross-referencing to be useful. Data can be arranged by format, narrative sequence or location so that it feeds naturally into a planned presentation. (Ehrhardt and Gross, 2000)

On returning from the site, the information's completeness should be reviewed to determine the need for further site visits. The information may be collated like a jigsaw puzzle, or interpreted into diagrams so that patterns can be seen from the fragments. By analysing highlights and deficiencies, design opportunities can be identified.

The results can be presented simply, as in pinned-up photos, or elaborately, as in interactive multimedia websites. Expandable formats foster a site description that becomes more complete from revisiting a site over time (Lynch, 1972). Web presentations can be adaptable by centralizing information and inviting online contributions.

Throughout the recording, analysis, and presentation stages and then during the design process, the artefacts of site information feed reflection about how to create a responsive design solution.

Collection phases vary according to media

Observing students on site visits revealed how each site-recording phases is shaped by tools employed. For example, at the site, students sketching had long periods of seated reflection at a

few selected places, listening to nature and observing subtle details. In contrast, those with cameras moved freely through the site, covering much more geographic area, gaining a richer haptic experience.

Because methods generate different kinds and amounts of raw data, they require different kinds of post-processing. Slower methods of recording, such as sketching, might lead to more on-site reflection but yield less data at the end of the day. Quicker methods, such as photography and video, may curtail meditative pauses, but record great amounts of data that facilitate reflection afterwards. The sketcher can walk away from the site with finished product while a prolific photographer or video team needs to put time and care into editing. While editing a large number of images or video segments can be time-consuming and cumbersome, the resulting presentation can contain much more information than sketches. Photos and video can show information in vivid detail, providing a comprehensive record for verification and enrichment.

In contrast, serendipitous experiments and idiosyncratic sketches may lack copious amount of objective information but can provide a personal site interpretation that feeds the design process. More intuitive onsite experimentation can be fostered by the expectation of a simple editing process.

Trade-offs with new tools

Many issues about traditional tools, such as the trade-off between collection time and editing time, extend to new tools. Tools that assist in speedy collection of raw data collection require additional tools to rectify, consolidate and interpret data. 3D scanners such as the environmental Cyrax system quickly read complex forms with precision by measuring the time of flight for a laser pulses. At a smaller scale items (shoes to cars), laser-stripe triangulation scanners, such as the Cyberware equipment used for the Digital Michaelangelo project, generate surface profiles by measuring from an oblique view the distortion of a laser line as it crosses a raised or depressed surface.

The resulting masses of digitized data require filtering into a usable form. Akin to raster to vector conversion, point clouds from 3D scanners must be grouped into polygons for efficient rendering and into geometric forms or NURBS surfaces for controlled modelling. Simpler collection methods can substitute for automatic acquisition. For example, desktop digitizers by Immersion and others allows manual point by point input of 3D coordinates, slowly generating a digital model from physical from. While the method lacks the speed of laser scanners, the sparser data can be input in a logical way, requiring no filtering but some error checking. Collecting sparser but more crucial and more organized data saves editing time afterwards.

Tools to consolidate fragmentary data and confirm consistency can increase efficiency by identifying errors onsite. Tools like PocketCAD for Windows CE and AutoCad View provide simple drawing and mark-up capabilities on palmtop computers so that measurements and annotations of existing conditions can be combined onto one file. Individually collected information can be shared through wireless devices.

On returning from the site, other tools can assist in making the collected information useful. Photomodeler mimics more expensive photogrammetry systems in generating 3D models by having the user pick out features that are common to photos taking at different vantage points. Tools like Erhardt and Gross' Placemaker (2000) help organize place images for the Web, keying annotated photos and panoramas into an orienting key plan. By providing a logical format, the tool assists users in creating a professional multimedia presentation.

As preparation to studying how these new tools affect the site recording and publishing process, the author and assistant, Katalin Czege, compared readily available tools.

METHODOLOGY

We prepared for guiding students site visits through preliminary trials with sketchbook, digital camera + audiotape and videotape. The trials provided a basic understanding of logistical constraints, procedural mechanisms and perceptual influences. We inspected a variety of digital place-based presentations and created our own Web field report on a place. We then sent students on site

visits with sketchbooks and cameras (and in one case video) to capture place information. The reports contained what the students chose as the most relevant, characteristic, legible or memorable information and summaries of what they thought about the site. We inspected these reports for the influence of the tools.

Would the differences between media would be evident in the Web pages created from the site visits? We conjectured that counting the kinds of images in the presentations could give a quantitative look at media's influence.

We sorted the media broadly with the Sketch category including watercolour, charcoal, pencil and pen. While we could guess what was drawn on site, it was not clear which sketches were made from photographs. Likewise, since we couldn't clearly distinguish between scanned film and digital camera images, they were both considered to be in the Photo category. Video was taken with an analogue video-tape-recorder. While it was would have been desirable to capture audio notes, sound was only captured on the videotape.

To parse the captured information, we had to invent categories. Initial thoughts to sort images by content (spatial order, human activity, natural forces and cultural meaning) proved too subjective. The image counts mirrored the site locations closely rather than revealing about media types. Instead, we chose to distinguish architectural versus natural subject and estimate the scale of the image. For scale, the imagery was sorted according to the distance of the viewpoint to target of interest. The analysis spreadsheet contained the following categories:

Table 1. Categories for logging websites

Identifier	Name	Login name identifying website
	Group	Course number and instructor
	Medium	Tool used for recording information
Scale and subject	Site Vistas	Long urban views and panoramic images
	Site Elements	Middle-distance images of natural components
	Site Textures	Close-up shots of natural elements
	Architectural Forms	Complete buildings & overall views of man-made forms
	Architectural Elements	Middle-distance images of man-made components
	Architectural Materials	Close-up shots of man-made objects

Figure 2. Categories shown in photos: Top: Site vistas, Architectural forms, Middle row: site elements & architectural elements, Bottom: Architectural forms, elements & materials

Context: designers, duration, site type, objectives

In each case, architecture students in a first professional degree program with basic Web authoring training, collected information at their studio project sites for a few hours and then summarized the information over a week or two.

In the first group, 30 students visited a natural undeveloped hillside to find and record the site for their upcoming studio project. In the second group, 21 first year graduate students in a computer graphics class visited their studio sites, individually or in small groups. Only those in the same design studio designing for an empty lot were included in

the study. For comparison, we also looked at a third group, 85 second year undergraduates, who had gone together to an urban site with specific issues to address and a fourth non-digital group who created printed rather than online reports.

The first group generated 10 pages with photos (average 2.9 photos) and 8 pages with sketches (average 5.0 sketches) and one edited video. The second group created 21 pages with photos (average 2.4 photos), 2 pages with sketches and photos (average 3.5 images). The third studio group, working in groups of about seven students, created 18 more elaborate reports (average 7.7 images). The fourth group created 5 pages with sketches (average 2.6 images) and 6 pages with photos (average 7.0 images).

Data: what did the tools capture?

In the first group, compared to the sketchers, the photographers concentrated on more natural elements (86% to 68%). This could have been due to the fact that groups gathered and rested close to built structures, allowing time for sketching. For this case, both groups concentrated on either the very large scale or on very small scale (primarily natural textures). At the middle scale, both groups registered few examples of natural elements (one case or 3%) compared to architectural elements (8%). The designers saw natural elements as a part of a larger whole, whereas perhaps due to their training, they recognized architectural elements as having a more pronounced character worthy of highlighting.

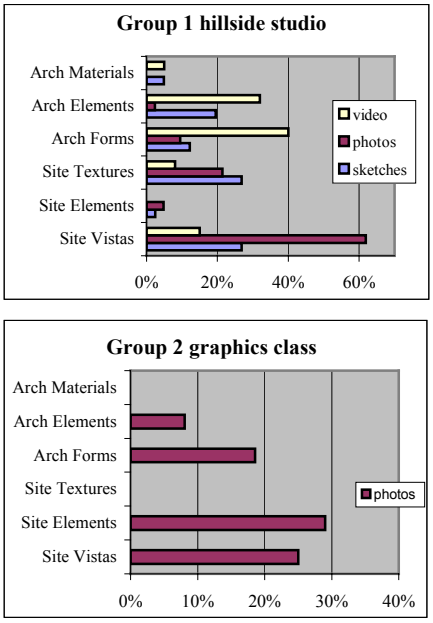


Figure 3. Image tally by media for groups 1 & 2

Students in the second group opted to use digital cameras over scanning sketches perhaps because it was faster and the class had a digital agenda. They concentrated on site elements (29%), and vistas (25%) with less attention to complete building forms (19%) architectural elements (8%).

Because of the third group's agenda to look at urban continuity, they recorded large-scale information (80% of sketches and 82% of photos) much more frequently than medium or small-scale information. In comparing use of photos vs. use of sketches, students used photos much more than sketches for the large-scale site vistas, especially when they contained natural elements. Sketches, by contrast, were used for building scale pieces, with some drawn from photographs. Students found it easier to draw the regular geometric order of man-made forms rather than the complex chaos found in nature.

The fourth group went to a site that was primarily natural with adjacent buildings primarily on one side. This was reflected in the dominance of the site images (88% of the photos & 85% of the sketches) over architectural images. As with the other groups, photographs were used more than

drawings for site vistas and drawings were used more for identifiable objects (site elements and architectural elements).

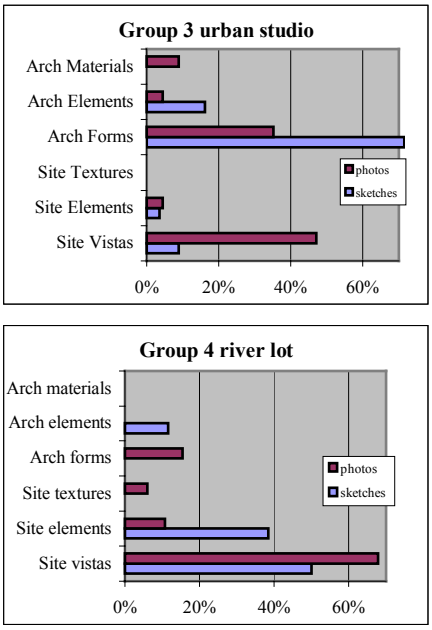


Figure 4. Image tally by media for groups 3 & 4

Qualitative aspects of the Group 1 video

Video from the first studio group visit was consolidated into a single tape. So while it is statistically insignificant, the video was logged to try a comparison method. Segments of the video were labelled with one of the six scale and content categories, and according to the duration of each segment, a percentage was assigned to each category. This procedure made it possible to compare video to the photos. The video's anomalous emphasis on architecture over nature (72% vs. 18%) reflected that its ability to work better than film cameras under low-light interior conditions.

Reviewing the video produced the following qualitative observations. It gave a very vivid sense of capturing an ephemeral moment because of it arbitrarily captured people in specific activities with bits of particular conversations. The imperfect shaky camera and occasional voice-overs gave a stronger presence to the author than still images. Spatial adjacencies and rough orientation came through, but absolute relationships were difficult to perceive.

V. Discussion

In looking at all the groups together, there is not a clear correlation between the recording medium and tallied report image categories. Within the wide variation of media use between groups, we observed a few tendencies. The students used photography for subjects too complex to draw, such as urban panoramas and organic textures. In all media, they highlighted things they knew well, such as architectural elements, and let less interesting pieces fall into larger views. They displayed both assigned information, such as building facades, and their own choice of engaging details. To generalize, people capture a subset of what is at a location depending on what they are looking for and their ability to find and recognize it. Individuals will do different things with tools depending on their training, talent, and interests.

The study revealed the role of influencing factors in place recording and the study of place recording. Among the many variables in the site recording process, the subject's intentions and the character of the site appeared to be the most critical factors in defining what is collected. The type of tools and students training followed in importance. So to understand media variation, it is crucial to hold send all subjects to the same sites with the same directions.

Media Constraints & new tools

Observing and trying place-recording methods accentuated how each medium engages the user to tailor work to its nature. The tools invite us to make an appealing artefact and control how this can be done. "Every type of visual, numerical, and verbal representation follows its own logic, "talking back" to the designer and clouding the relationship between representation and reality." (Bosselman 2000) Creating a pleasing composition becomes as important as recording important information. Circumstantial details like fleeting sunshine can make secondary forms inviting. Conversely, some subjects do not fit some techniques. Silence on audiotape or stillness in video compels us to create

drama or motion, vast repetitive fields challenge sketch artists.

While each tool frames its results, simpler tools tend to be more versatile and high-tech tools more constrained. Sketchbooks can carry representational images, analytic diagrams, and text in idiosyncratic ways, but their digital equivalents such as personal digital assistants, constrain input techniques more narrowly. As new tools are precisely tuned to specific tasks, tool selection becomes more critical. Just as tight interiors require a wide-angle lens, situations can demand specific kinds of tools.

The specialization of each medium means that resulting products cannot be parsed in the same way for analysis. The nature of a tool's raw data and its manipulation must be considered in guiding the site recording process and in characterizing the resulting products. Perspective images are more naturally categorized according to pictorial aspects, such as viewpoint distance, than by logocentric content categories. Sentences can be sorted into abstract content categories (spatial, cultural, natural, cultural) more easily than images since text articulates conceptual thinking more clearly than graphics. Examining additional place videotapes (Kellett & Girling 2000) confirmed that a measurement's usefulness is dependent on the medium. While it was possible to translate the image tally to video time segments, tallying viewpoint distance became less interesting after the cameraperson standardized shots to fixed-location zooming and panning to reduce camera shakiness.

VI. Future Work: alternative approaches to studying place-recording

In this round, tallying web page imagery was more useful for revealing a group's site recording interests than for showing tool bias. With modification, field report analysis could be more informative about the media's influence on vision and perception. Comparing concrete factors such as the perceived dimension of represented vs. real objects could be more fruitful than the image tallies. Supplementing website analysis with interviews or thinking-aloud sessions would illuminate more of the process-process connections. (see Herbert 1993 & Robbins 1994) For new tools, the protocol could include using subjects to review the created material:

1. *Preparation:* Make pilot trials with audio taped notes, train students in using tools.
2. *Field Visit:* Design students visit a compelling place with different toolkits using audiotape annotation, then summarize findings for the Web
3. *Survey:* Web authors are queried about site features to track site perceptions and memories.
4. *Review:* Other students examine the Web reports; describe differences in how the presentations capture sense of place and scale, before and after visiting the site.
5. *Analysis:* Web pages, surveys, audiotapes and student reviews are examined for robustness of place description and accuracy of scale depiction.

With the long-range goal of defining task-appropriate toolkits, this study begins to document how tools affect field recording and examines one way to look at Web-based site documentation. Related investigations include:

- Refining the methodology for studying site-recording,
- Comparative testing of recording tools
- Examining media's role in successful site-specific designs
- Tracking representations in site perceptions during the design process
- Developing more robust representations.

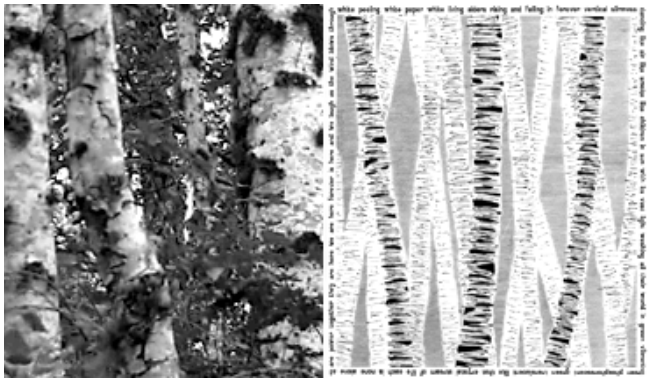


Figure 5. Media shapes what is captured: sketch shows abstract concept of alders

Both methodical research and creative exploration can contribute to our understanding of place representations. In a recent study on the representation of non-visual site information, Robitaille (2000) explored collage techniques to record sensations of touch, sounds and smells in an environment. This type of artistic approach can be appropriate because a designer needs not only factual information, but also details shaping the gestalt of a place. Randolph Hester, a landscape architect, described on-site sketching as "visual listening: looking so carefully that you pick up essential spatial details that create the uniqueness of a site…. Active meditation reveals the essence of a place, the soul that touches your heart." (1993) The ephemeral moment of long diagonal shadows or a squirrel jumping across a frame can strike a chord and bring the designer back to that moment of being there. Part of the job of understanding a site is becoming aware and open enough to see the unexpected, to relish the moment of just experiencing what happens.

So a balance needs to be struck between rational procedures and intuitive gathering. Checklists of site information topics (White 1983) can make examinations more comprehensive, but may constrain observations to those expected from traditional tools. Too tight a recording protocol would make it difficult to pick up serendipitous events that stimulate design. Tony Hiss explains that sometimes looking a single mode search is not enough: "One part of experiencing places, for instance, has to do with changing the way we look at things, diffusing our attention and also relaxing its intensity—a change that lets us start to see all the things around us at once and yet also look calmly and steadily at each one of them." (1990, p. 34) Rather than defining what should be found, we should concentrate on defining procedures for searching. In this way, we can guide site surveys to be comprehensive and efficient while fostering the circumstantial perceptions that can spur design thinking. Reviewing the student websites showed that we see what we look for and we see what we can name. Our challenge is to open our eyes to what we're not looking for.

Acknowledgements

Katalin Czege, Ronald Kellett, G.Z.Brown and Stephen Lamb helped shape and encourage the ideas in this paper. The University of Oregon Foundation and the Intel Corporation provided support for this enquiry.

References

Bosselman, Peter, 1998, *Representation of Places*, Univ of California Press, Berkeley, p. 187

Corner, J., 1992, "Representation and landscape", in *Word and Image*, 8(3), p. 243-275.

Crowe, N. and P. Laseau, 1984, *Visual Notes,* Wiley & Sons, New York

Downing, Frances, 2000, *Remembrance and The Design of Place,* Texas A&M Press, College Station, TX.

Ehrhardt, M. and M. Gross, 2000, "Place Based Web Resources for Historic Buildings", *ECAADE 2000*, pp. 177-179

Herbert, D., 1993, *Architectural Study Drawings*, VNR, New York.

Hester, R., 1993, in "Portfolios [drawings of landscape architects]", in *Landscape Architecture*, May 1993, 83(5), p. 57-63.

Hiss, T., 1990, *The Experience of Place*, Knopf, New York

Lynch, K., 1972, *What Time is this Place?,* MIT Press, Cambridge, MA

Robbins, E., *Why Architects Draw,* MIT Press, Cambridge, MA.

Robitaille, Sophie, 2000, *Make Sense,* unpublished M.L.A. thesis, University of Oregon

White, E. T., 1983, *Site Analysis*, Architectural Media, Ltd., Tallahassee, FL.

ARCHITECTURE AS A KNOWLEDGE-BASED TOOL: THE ARCHITECTURAL TRANSFORMATION OF WORKSPACES

Fatih A. Rifki, Ph.D. *Associate Professor of Architecture, College of Design, School of Architecture, NCSU.*

Umut Toker, *Ph.D. Student, College of Design, School of Architecture, NCSU.*

1. Introduction: An Era of Technological Innovations

In these early days of the twenty-first century the pace of innovations in technological developments is phenomenal. A common example: the personal computers that we were using five years ago – which did not even exist about twenty five years ago – are now –for all intents and purposes useless today. The speed of technological innovations and product development has reached such an extent that almost every one of us has some outdated "technological" tool, which is yet to be "upgraded" to the latest technology.

While many disciplines are in constant state of inquiry – both for understanding the factors that necessitate these fast paced developments, and ways of supporting and utilizing the developments themselves, is architecture merely accommodating these technologies – i.e., is it simply a "spectator"? Or, can architecture be a discipline or realm to support these fast paced technological developments and innovations, - i.e., is it a "player"? Which role is more appropriate for architecture, or which positions for architects can highlight architecture as an important force of this era of constant and rapid technological change and development?

We can begin searching for the importance and place of technological innovations in today's world by acknowledging the three contemporary "revolutions", which are historically interrelated. First is the technological revolution, which is as significant as the industrial revolution. Second, there is the formation of a global economy – the continuity of economic processes on the planet scale – marking a worldwide interdependence among nations. Third, and the most important, is the formation of an "informational economy", where productivity and competitiveness are dependent on the creation of knowledge and flow of information, which clearly marks the importance of technological innovation (Castells and Hall 1994).

Obviously, the importance of knowledge is a more recent phenomenon, i.e., of the last decades of twentieth century. The last two centuries were marked with the shift from agrarian economies to industrial economies, through the Enlightenment and the Industrial Revolution, both of which had different focal points. However, the realm of architecture has responded to these changes in different ways, in order to support these changes in society. One important issue at this point is that, architects have attempted in various ways to employ their expertise as a knowledge-based tool to support either industrial, or recently, informational economies. In addition to the fundamentals of the profession of architecture, such knowledge-based attempts have formed a complementary 'paradigm' in architecture.

The main objective of this paper is to discuss these attempts, starting from the late nineteenth century, until today, through the development of workspaces. Design of workspaces, either as production facilities, or to house the service sector, have been a major area of search and research in architecture, for the utilization of a knowledge base. As scientific developments have taken place, different approaches to designing workspaces, i.e., typologies, have been developed, such as factories and office buildings. Today, research and development facilities have also been added to this repertoire of building types. This paper focuses on the mentioned paradigm, through a search on the development of office buildings, which in most cases also house research and development activities.

In doing so, attempts to exhibit the various ways in which architects have responded to the

changes in the conception and design of the workspace – economical, technological, or informational – through utilizing a knowledge base, thus utilizing architecture as a knowledge based tool: architecture as a form of technology. The paper concludes with informed speculations on the future practice and research opportunities on the architecture of workspace.

2. Initial Attempts

The attempts to employ architecture as a technology itself have their roots in the early stages of the Industrial Revolution. As in many other areas of human society, the Industrial Revolution, marking the transformation from agrarian to industrial economies, has had a significant impact on the evolution of the workspace.

The industrial revolution is hard to consider without the idea of enlightenment. 'Enlightenment', as an understanding, has yielded the notion of the 'autonomous man'. Within this understanding, a distancing of man from the nature and dark primeval forces, and a quest for control of nature and himself accompany each other. The idea of enlightenment, described as the great rationalization of the Western world, has cultivated modernity as a condition, sharing much with the Industrial Revolution of nineteenth century, which, consequently induced scientific and technical rationality (Muller 1991).

The scientific and technical rationality that began to be dominant for the first time in this period was supported by three factors. First, capitalism, as a system where effort is mainly geared towards obtaining maximum return from the least amount of investment, became an important goal. Moreover, the Protestant ethic, where moral values were attributed to non-moral activities, one of which is work, consequently had a significant impact on the understanding of work and the workspace. Hard work now, had a moral value, affecting the value systems and moral worlds of the "workers". Another important factor was that, this overall series of developments was encouraged with the technological and scientific successes (Brolin 1976). This era marks the beginnings of the entry of scientific and technical rationality in the realm of architecture.

The reflections of these developments on the formation and spatial organization of the workspace needs to be discussed through managerial science. It was the idea of managerial science that formed the concept of work organization, and therefore, induced the formation of specific spatial organizations of the workspace. This also marks the attempts to employ workspace architecture as a technology: a technology to be utilized for the purposes of maximum productivity in the workspace.

As a major contributor to the study of managerial science, Frederick Winslow Taylor was a pioneer to affect the spatial formation of the workspace.

Taylor's principles on work do not solely focus on the office, but is a contribution to the realm or idea of 'work' as a whole. Having its basis on the notion that "...people can be managed best when they are treated as unthinking automations...", Taylorism proposed some managerial ideas about work, such as the careful observation and ruthless control over work, treating people as if they were simple and many units of production, observing people with a stop-watch, punctuality and synchrony, and no expectation of intelligence and inventiveness from the 'worker', either in the office or the factory.

The waste of human effort through the ways which work was conducted was a main point for Taylor's approach. Depending on his own experience, he was convinced that the actual movements of men at work were wasteful and ill directed. Russell (1981) argues that Taylor was after training workers according to the system, instead of searching for competent men:

"All this was effected by minutely timing the work processes, the movements of the men and the positions of machines and tools. From this the movements and processes seen as being most economic of time and effort were set down as norms for the job with the result that production went up and the wages also went up... (Russell 1981: 86)"

These ideas clearly had much to do with the physical formation and spatial organization of the workspace, and the utilization of workspace architecture for the support of work.

When one focuses on the effects of Taylorist principles on the workspace, the results are somewhat similar on nearly all examples: one large space for the 'office-workers', or clerks to do clerical tasks in, mostly linearly organized, and higher status workers with their enclosed offices on the periphery, to supervise the clerks. It is argued that the crystallization of Taylorist principles is exhibited in Frank Lloyd Wright's Larkin Building (Duffy 1997) (Figures 1 and 2).

Figure 1. Larkin Building 1906. Interior, Architect: Frank Lloyd Wright (Source: Albtecht and Broikos, 2000: 48).

In order to cope with the Larkin Company's business of mail order, and to handle vast amounts of paper based information necessary for business, a large and disciplined group of clerks was needed. Wright's solution to the problem was a strictly ordered linear space, where the clerks were expected to work within a strictly ordered structure. *"It was probably ... the most perfect relationship between architectural invention and organizational innovation that has ever been achieved"* claims Duffy (1997), regarding this solution. Larkin Building was one of the first examples of utilizing architecture for the purposes of supporting work in the workspace: architecture was now a technology in and of itself. In other words, architecture was turning into a knowledge-based tool.

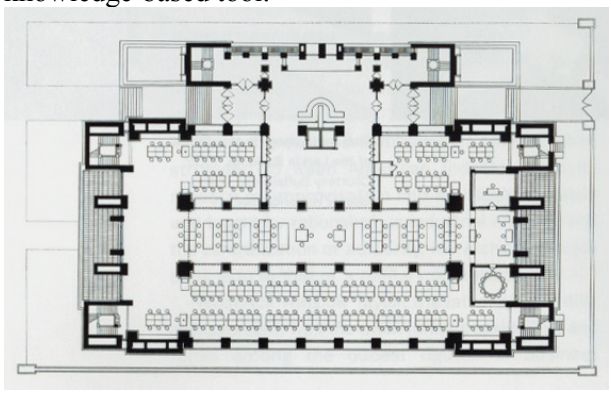


Figure 2. Larkin Building, 1906. Plan, Architect: Frank Lloyd Wright (Source: Albtecht and Broikos, 2000: 51).

3. Twentieth Century

There have been numerous changes and developments in the conception of workspace and the response of architecture to these, since the Industrial Revolution and principles of Taylorism. The post World War II developments in Europe and North America are worth considering in this respect.

Although the genesis of workspaces in the form of office buildings parallels the developments in "organization" in the United States, the two directions of development diverge in the post-war period. The custom designed office buildings such as Larkin Building gradually left the scene under the pressures of real estate development, forming a new type of office building, which was to be called "speculative offices".

The "speculative offices" were basically developers' speculations in the real estate market where offices had a mere "exchange value" (Worthington 1997). These were randomly built

office buildings on lots with a high real estate value, where the owner or the developer was able to either sell or rent a portion of office area. The "thin slab office tower" offered maximum profit with the highest number of floors. Partitions were placed on the slabs according to the request of the user, and renting or selling trends of the area (Laing 1997). Today, these speculative office buildings are ubiquitous in many North American cities.

Eventually, the speculative office industry turned into a building industry of "skin trade", where the architect was expected to provide maximum flexible area to be divided in a multi-floored block, leaving the interiors entirely to the interior designer. Such shiny glass covered rectangular prisms had a considerable effect on the silhouette of most North American cities. The glass office tower on a podium turned into a "fashion", where companies or organizations were able to rent or buy as much area as they needed (Laing 1997). Obviously, these speculative offices had not much in common with the idea of a knowledge-based response to the nature of work.

Meanwhile, the developments in Europe were more close to the idea of employing architecture as a knowledge-based tool. During the "invasion" of the speculative office buildings in the United States, reactions against the lack of link between work patterns and workspace design were forthcoming in Europe. The idea of relating design of office buildings to the work pattern to be housed was an "awakening" in the continent.

The concept of "burolandschaft" was introduced in Germany by Quickborner team in 1959. The basic concept of "burolandschaft" was an emphasis on the need for better communication in the workspace, supported by the design of the office, based on an analysis of the work patterns of office organizations. The routes of paper flow in the office, as well as the visual communication among office employees were the main factors determining the work setting design, i.e., spatial organization. Another argument in favor of the concept was that it eliminated segregation due to status differences; that is to say, it was an attempt to flatten hierarchy (Laing 1997). This understanding of the relationship between work patterns and work settings led to the creation of open workspaces in large, deep floor slabs, where clerks occupied large open spaces, whereas managers occupied private enclosed offices (Figure 3). The main difference of the concept of burolandschaft from speculative offices was that, whole layout was dependent on work pattern, instead of commercial restraints or opportunities. This was the introduction of a "use value" of an office building (Worthington 1997).

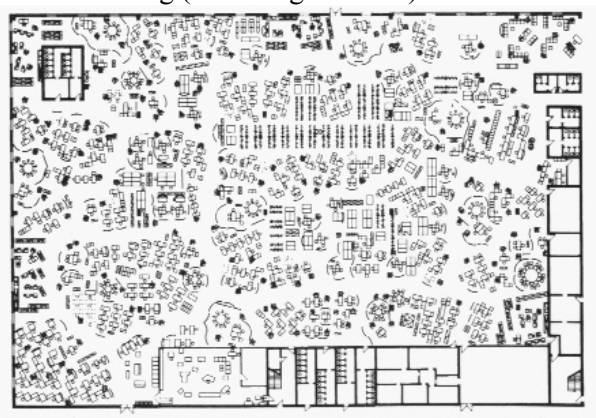


Figure 3. The concept of burolandschaft: GEG Versand Kamen building, floor plan (Source: Laing 1997: 28).

Despite the fact that the concept of burolandschaft remained within the concerns of interior design and work setting, it was an important awakening, in regards to the relationship between work pattern and design of the office workspace, thus, as a knowledge-based response to the nature of work by architects.

4. Changes: the Rise of Knowledge

The last two decades of the twentieth century have been significant for the vast amount of changes and developments that have been experienced. The introduction of new work patterns, high speed developments in information and communication technologies, flattening hierarchies, the introduction of knowledge as a commodity have all had great impacts on the evolution and developments of workspaces, through the responses of architecture (Duffy 1997).

In order to draw a clear picture of what has happened and is happening, a general framework can be proposed. The introduction of knowledge as a commodity by the end of twentieth century, which was a consequence of economic developments, has had enormous impacts on the workspace. The idea of "knowledge as a commodity" has reflections on many dimensions of the workspace environment, from new work patterns to new concepts of spatial organization. Additionally, one obviously has to consider the impact of the introduction of information and communication technologies on workspace environments, which are no less than those of "the idea of knowledge as a commodity". Thus, these two points, namely, *"the idea of knowledge as a commodity"* and *"the introduction of information and communication technologies in the workspace environment"* constitute the basis for the recent evolution of office environments, both in the scale of operation and design.

The attempts to employ architecture as a knowledge-based tool for workspaces have resulted in various research and design approaches. Among these, recent research by Duffy et al. (1998) looks at the changes in the work patterns, in order to build an empirical knowledge base to be utilized in workspace design. This research into the changes in work patterns can be summarized as in Table 1, where 'Conventional' vs. 'New' work patterns are compared. This comparison clearly exhibits the changes in the nature of work, and the need for architects to be informed about recent information about these changes.

Table 1. 'Conventional' versus 'new' work patterns.

'Conventional' work patterns	*'New' work patterns*
Routine processes	Creative knowledge work
Individual tasks	Groups, teams, projects
Work breakdown to small components	Collaborative and individual work
Work carried out by staff given precise instructions	Work process constantly redesigned
Precise timetable	Complex timetable
Full time occupancy of space	Task based occupancy of space
Individual space	Shared space
Alone or isolated work	Combined *interactive* and *autonomous* work

As a result of their research into the work patterns, Duffy et al. propose four optimized spatial configurations of workspace, where the main variables are interaction and autonomy: hive, cell, den and club. As interaction and autonomy increases, the workspace approaches today's innovative workspace. The authors summarize the spatial implications of these four types as shown in Figure 4 below.

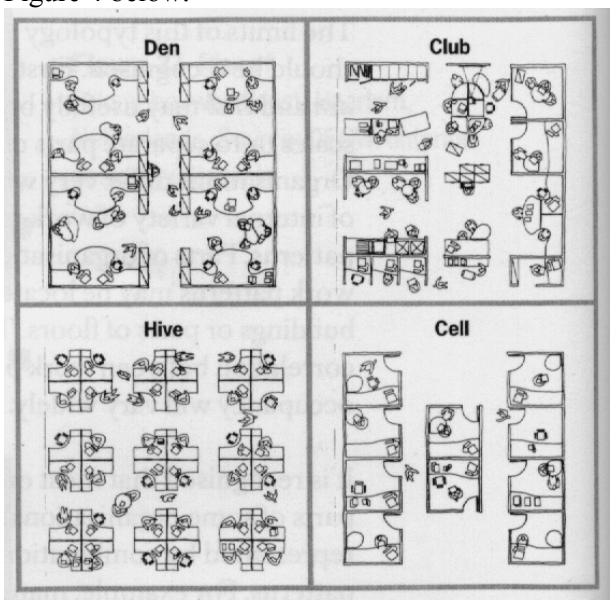


Figure 4. The four optimized spatial configurations (Source: Duffy et al, 1998: 26).

Duffy et al.'s work is an approach to the idea of utilizing architecture as a knowledge-based

tool (Figure 5), where some optimized spatial organizations are provided, to be used by designers.

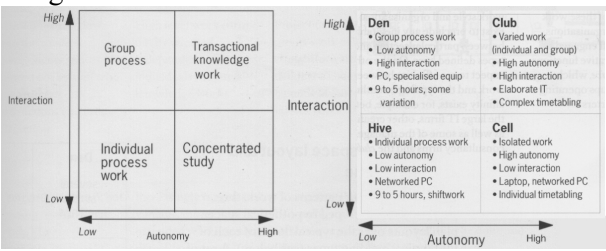


Figure 5. The four optimized spatial configurations and work patterns (Source: Duffy et al, 1998: 26).

Hillier and his colleagues, utilizing the space syntax method, pursue another point of departure in their research. The methodology used in this research searches for the interactive 'hot-spots' in the workspace, in order to find the tools and ways to support the innovation processes in today's workspace (Hillier 1996). Although Hillier and his colleagues' research does not yield some optimized spatial configurations, their studies evidently provide a quantitative approach, where the role of designers' intuition is potentially minimized.

5. Conclusions: Future Opportunities for Architecture and Architectural Research

Economical and technological advancement is an integral part of the objectives of contemporary societies. It is now evident that knowledge is a commodity, and the developments favor creation of knowledge and knowledge-based products and services. The question at this point is whether architecture will be able to contribute to the advancement of contemporary societies with the necessary means to support fast-paced technological developments, moreover, the creation of knowledge.

In a recent article, Gwendolyn Wright, while discussing "The Virtual Architecture of Silicon Valley", points out the fact that architects have not been able to intervene in the formation of this *"Mecca of digital technology"* to a large extent (2000: 88). Moreover, one of her statements reveal how critical this era is for the legitimization of architecture and its products:

"Most of the people who work here [Silicon Valley] *only notice architecture when it gets in the way (Wright 2000: 93)."*

It may be the time for architecture to admit that it **has** to contribute to the life of contemporary societies in ways different than it does today or has done in the past. By now, it seems evident that workspace design is an area that has a great potential for architects to contribute to the contemporary technological developments, and find new means of legitimization for the profession. For architects to provide the public with efficient 'tools' of development, and therefore support the innovation processes in such settings, knowledge-based contributions to the fundamentals of the profession is vital. In this respect, effective research by the scholars of architecture, as well as efficient means of communication to the practitioners of architecture has to be nurtured.

Introducing architecture to contemporary societies as a redefined technology among other technological advances will be a challenge for the realm of architecture in the twenty-first century. To cope with the pace of technological advances created by the 'innovative geniuses' of this century, a complementary knowledge base to the 'iconic gestures' (Figure 6) of architectural traditions is crucial.

Figure 6. Oracle Campus, Silicon Valley, CA (1989 – 1998, Architect: Mitchell Schwarze, Photo by Umut Toker).

6. References

- Albrecht, D. and B. Broikos Chrysanthe, eds. 2000. *On The Job: Design And The American Office.* New York: Princeton Architectural Press.
- Brolin, B. C. 1976. *The Failure of Modern Architecture.* New York: Van Nostrand Reinhold.
- Castells, M., Hall, P. 1994. *Technopoles of the World: The Making of Twenty-first-century Industrial Complexes.* Routledge, London.
- Duffy, F. 1997. *The New Office.* London: Conran Octopus.
- Duffy, F., Laing, A., Jaunzens, D., Willis, S. 1998. *New Environments for Working: The Re- design of Offices and Environmental Systems for New Ways of Working.* London: Construction Research Communications Ltd.
- Hillier, B. 1996. *Space is the Machine: a Configurational Theory of Architecture.* Cambridge; New York : Cambridge University Press.
- Laing, A. 1997. "New Patterns of Work: The Design of the Office", in *Reinventing the Workplace, ed.* J. Worthington, Oxford: Architectural Press.
- Muller, A. M. 1991. "The Dialectic of Modernism", in *Architecture in Transition, ed*. P. Noever, Munich: Prestel. London: John Wiley & Sons.
- Worthington, J. 1997. "Introduction: The Changing Workplace", in *Reinventing the Workplace, ed.* J. Worthington, Oxford: Architectural Press.
- Wright, G. 2000. "The Virtual Architecture of Silicon Valley", in *Journal of Architectural Education, v. 54, no. 2.* Cambridge, MA: MIT Press.

THE BUILDING OF RESEARCH:
A Center for the Study of Educational Facilities

A. J. Davis, Reynolds Professor of Architecture, Virginia Tech

Introduction

According to a 1996 General Accounting Office study, "More than 14 million children are being taught in school buildings needing significant repairs to restore them to good overall condition" (GAO/HEHS-96-103). Since then that number has grown significantly. As much as $112 billion will be spent with little research or documentation to assure those problems of the past 40 years will not be repeated (GAO/HEHS-95

). Another study by The Council of Educational Facility Planners International has identified a need for over $200 billion in school construction in the United States. They cite cities "like Las Vegas and Miami, where the populations are increasing at a rate of 5,000 people per month, find that they don't have time to think about designing schools in new, more effective ways. Instead, they defer to obsolete models of learning environment configuration; perhaps housed in new skins, but essentially designed on old models of teaching and learning." In addition there are numerous new and threatening conditions of which science and health officials are now aware, that can be inadvertently designed into educational facilities. Many of the nation's schools were designed in the 1950's and 60's and are facing serious deterioration. Those that still have value need renovation while others need to be completely replaced.

The current trend in new schools is to select previously designed buildings. These are often from localities in completely different climatic zones, site conditions and construction markets. This process is so prevalent and rapid that many of the previously designed buildings have not been used long enough to determine particular problems such as energy use or indoor air quality consequences that may be constructed again in their reuse. It is not uncommon to hear of school districts repeating problems in several new buildings in the same year.

The growing body of research linking student achievement and behavior to the physical conditions and environments of school buildings is significant. Consequently with the millions of school children affected and the billions to be spent, there needs to be a comprehensive center for the study of physical design criteria. This center would require a facility that supports specific technical research into many arenas. Where as the building could demonstrate the appropriate applications of some of the areas, it would also provide the necessary support structure to research others.

A research complex that can support the study of existing and proposed educational facilities would need to support at least 14 inter-related research areas:

- Site analysis issues
- Natural system compatibility
- Structural systems
- Materials and finishes
- Indoor air quality including VOC's, temperature, humidity and ventilation
- Acoustics
- Envelope (roof, walls, fenestration and slab)
- Mechanical systems
- Electrical and technology systems including power, lighting, security and other 'smart systems'
- Building delivery systems
- Design and Construction Contract implications
- Facilities Management
- Software modeling for predictive results
- Industrial design of building components and furniture

Critical Research Areas

The 14 research areas mentioned above are preliminary but adequate for planning purposes. Ehrenkrantz (Ehrenkrantz 1989) writes that his research found that, "designing a single stock plan and fitting it to a variety of different sites where slope, orientation, and configuration differed…the costs of adapting any given plan to a variety of special situations were higher than they would be starting from scratch with a completely new design." The primary reason school boards tend to go the 'stock plan' route is to avoid or reduce architectural design fees. Since they usually have to hire a local architectural firm just to make modifications to the drawings to fit their specific intents and then to conform to the site conditions, the fees are ultimately equal if not higher than a design from the beginning. The end result is often higher site construction costs due to massive amounts of earth movement and higher design modification costs. A building not designed for a specific climate and site usually has a higher energy cost associated with it as well. To redesign the stock plan to accommodate natural ventilation or daylighting would often require massive changes to the design.

A Center that serves as a clearinghouse of information on evaluations of actual constructed facilities could offer a performance track record of decisions. It could employ modeling and simulation to evaluate new designs for specific sites in a wind tunnel or daylighting dome as well as have important full scale assemblies constructed for validation. Following each school's construction, data acquisition systems could be located to collect critical performance information.

Daylighting has been known for its significant contribution to environmental quality and energy conservation since the '30's. There have been trends in education and in early forms of energy conservation that attempted to counter that position. Now it is well known to both contribute to student achievement and to the education of students regarding environmental consciousness.

Educational Facilities Laboratories (EFL 1967) , "decided that a 60 foot span, or more, rather than the traditional 30 foot one, would be most useful, that many interior partitions should be demountable,…" In the late 60's this might have been state-of-the-art, but now that needs to be reviewed. Educational trends towards open classrooms have shifted back to more acoustically controlled classroom environments which can dramatically change the appropriate bay size. When daylighting and natural ventilation are considered, the interior dimensions may vary and consequently, change the structural bay dimensions. Innovative structural conditions or systems may also have cost and durability circumstances that need to be evaluated. Structural issues are integral to successful, cost effective educational facilities and need to be studied in the context of the other issues listed.

Secondary schools are subject to heavy wear and tear and of course vadalism is always an issue. The materials, finishes and hardware are subject to heavy use and occassional abuse. There are many products available that can possibly lower maintenance and repair costs. There are also products that can enhance daylighting while reducing glare, increase solar heat absorption and to simply improve the interior or exterior environment.While significant progress has been made through regulation, many products still release volitile organic compounds (VOC) into the indoor air. These often contribute to serious health hazards and post occupancy law suits to correct the problems.

Schools of the future need to be designed with integrated mechanical and natural systems with control strategies that assure high indoor environmental quality (IEQ). IEQ includes thermal, luminous, sonic and indoor air quality. If the temperature is too warm, students will tend to become drowsy, if there is too much noise, concentration and communication is disrupted and if the artificial lighting system is poorly designed than veiling reflections can cause eye strain. The proposed facility would provide for controlled laboratory experimentaion, field monitoring and computer simulation to analyzize IEQ issues.

The envelope of the school is the critical filter for conserving energy, providing natural

illumination and ventilation, reducing maintenance costs and protecting the occupants in the case of disasters such as fire and earthquakes. Full scale mock-ups provide the opportunity to structurally and materially test wall, roof and slab assemblies for thermal and energy transfer performance. In addition, wall sections can be constructed to test for daylight illumination and mechanical integration.

Heating, ventilating and air conditioning systems have many components that each have both energy and indoor air quality issues. Specialized filtering systems can reduce both VOC's and other airborn pollutants. Particular system configurations can vary with individual school designs. Each can have positive or negative reprocussions. If the system has duct work, whether the ducts are lined on the inside or the outside, perforated or not, are all conditions that affect the health of the delivered air. Cooling and heat exchange components can breed microbial diseases such as Legionairs and pnneumonia. Proper installation proceedures and construction practices can help reduce or eliminate the pollutants. Ventilation efficiency can drammatically affect the comfort of the occupants by the removal of indoor pollutants. A full scale classroom could be constructed in the mock-up space to test variable air volume cooling systems, displacement ventilation systems, reconfigurable heating and cooling systems and various computer based control algorithms. The same classroom mock-up could be used for electrical studies.

The classroom could be used to study various lighting strategies, lighting retrofits, and ventilation delivery methods relative to lights. It could also be used to study lamps, dimming ballasts, light shafts and photocells. In addition to lighting issues, power delivery methods could also be explored. These might include power strips, desk or lab table outlets, under carpet wiring, overhead cable trays, power poles, etc. Schools need to have special security systems to protect the property with surveillance and to protect faculty, administrators and students. The integration of these security systems into school design is both visual and power integration issues. The integration concerns also include the integration of world-wide web connection systems. Classrooms need to be wired for instant internet connections to minimize lost classroom time and increase library use efficiency. The access for the student is both an industrial design and an architectural design concern. Both can be studied in the context of an appropriate classroom mock-up.

With a Building Construction department being part of the College, access to study construction delivery contracts and methods is natural. As mentioned earlier in the introduction, school boards assumming that they are saving money by using stock plans and the lowest bid contractor, are often incorrect. A new design with construction management may in many cases appear to be the best approach but it can vary with specific conditions. With actual wall section construction and a classroom mock-up, a construction estimate can be very accurate and if too high, alternatives can be studied and proposed.

There are many software development opportunities for the study of ventilation distribution, lighting design, acoustic studies, thermal and heat loss studies, and of course for modeling interior environments, complete with furniture. Engineering firms, such as Ove Arup, have state-of-the-art software available for simulating specific environmental conditions. These would be utilized along side the physical model to achieve maximum accuracy. In addition to physical model evaluation, human subject response can often provide the most important data and can be collected in a mocked-up classroom.

Finally, with an in-house Industrial Design program, the furniture, human factor relationships and other important interior design issues would be studied in the mock-ups alongside the other previously mentioned environmental criteria.

Figure 1. Proposed Educational Facilities Research Center

The proposed educational facilities research center shown in Figure 1 above would include a multidisciplinary team of researchers that could evaluate existing designs or proposed school designs relative to all or selected issues. This K – 12 focus would position the facility and team to be a valuable resource to designers and governmental bodies on well-designed, healthy environments for learning.

Establishing Criteria

As Ezra Ehrenkrantz writes in Architectural Systems, any attempts to obtain a consensus on physical requirements from all the school boards and other governmental agencies building schools, would be fruitless. The different concepts of education would want to shape different requirements for the schools. Consequently, a flexible research complex that could afford a wide range of important research activities is necessary. Since the research performed would give designers the range of performance particular systems or component combinations would have, it is incumbent that there be spaces for prototypes and other full-scale environmental tests be provided.

Consequently two mock-up spaces for full-scale prototypes would be included. The spaces would have at least 18' high clearance and have overhead crane capability. With exposed HVAC systems and cable trays, environmental flexibility could be obtained. Natural daylighting through north facing skylights would provide balanced lighting conditions. If direct sunlight is required the mock-up could be rolled out to the staging area through overhead doors.

There are several demands that could be measured on mock-ups. These might include construction material and assembly, moisture transmission, solar heat gain, aesthetics, etc. The assembly would require shops capable of working in various materials. Therefore there would be three primary shops, one each for wood, for metal and for fiberglass. Nearby facilities allow for concrete and masonry construction. This combination of material fabrication capabilities would position the researchers to construct a wide variety of building components, HVAC systems and many other test assemblies.

Researchers would need offices and since educational support would be needed, there would be classrooms. There would also be support facilities for circulation, mechanical distribution and toilet rooms. Model testing would be necessary for many different lighting or ventilation studies so a wind tunnel and daylighting dome would be necessary. Most important is to retain flexibility and allow the primary spaces to change over time.

Figure 2 below illustrates a section through the proposed facility. It shows the two-story mock-
up space, office and classroom. The detail is of one

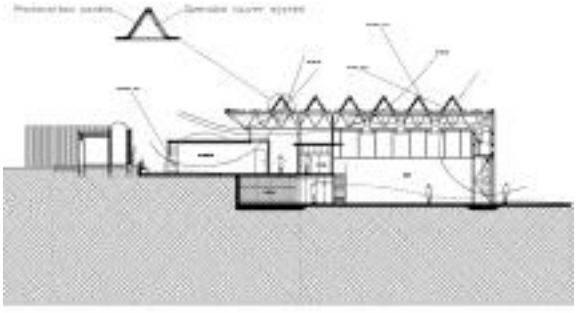


Figure 2. Section through proposed facility

of the monitors on the roof. Each monitor has a photovoltaic array to the south and a clearstory to the north.

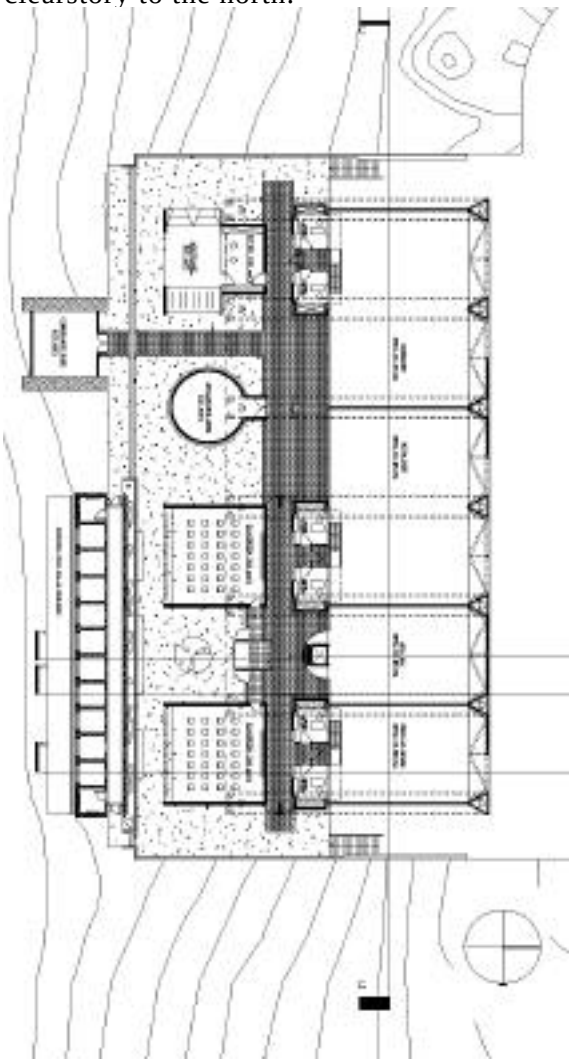


Figure 3. Plan of proposed facility.

Figure three illustrates a proposed plan reflecting the programmatic criteria just discussed. Shown are two 30-person classrooms, six offices, fiberglass shop, wind tunnel, daylighting dome, wood shop, metal shop and two mock-up spaces. The long cellular structure on the left is an existing test cell facility. This facility has two instrumentation rooms at both ends and ten 8'x8' cells with an open façade facing due south. These cells are for testing façade assemblies for solar gain, ventilation, daylighting and moisture penetration. The cells may be heated or cooled as necessary to determine thermal transfer. These can be wired for remote data transfer to a main instrumentation room in the nearby existing Research + Demonstration Facility. The three buildings would work together to provide a comprehensive research complex.

At least one of the mock-up spaces would be a climate-controlled environment. This would require enthalpy, relative humidity, CO2 and temperature sensors with a sophisticated thermal comfort controller. Some work currently on-going at the Research + Demonstration Facility relative to the design of a pediatric hospital room has shown that for full scale mock-ups to provide valid data for the duration of the research, they need to be in similar climate controlled environments.

In the other mock-up space, envelope assemblies could be tested for thermal transfer, moisture migration and air leakage factors. This would require humidifiers, pressurizing fans with variable frequency drives, pyranometers, a solar simulator, heat flux sensors and an overall system controller with a data acquisition dedicated computer. This equipment would allow different wall, roof, and slab assemblies to be studied.

The wind tunnel would be designed for model studies and would require a site built platform and housing. In the housing would be a variable frequency in-line fan with speed controller, pressure and velocity transducers smoke wand, and adjustable lighting system

The daylighting dome would likely be a stainless steel silo top with access door. Inside the surface would be modified to match a hemisphere dome. A motorized viewing platform with solar lamps and a sun simulator would be required. Also required would be a digital video camera with display system and a data acquisition dedicated computer for control.

The wood and metal shops would have equipment suitable for heavy construction as well as furniture fabrication. Areas for welding and spraying and painting booths would also be provided.

Summary

The origins of this facility lie in the fact that there is no one center that is an authoritative source for all issues affecting the design and construction and evaluation of K through 12 educational facilities. The Jefferson Center at the University of Virginia is a well-respected center for the study of pedagogical issues regarding K – 12 education. This center aims to have the same reputation for the study of physical design criteria through the design of a facility capable of handling the previously mentioned 14 criteria.

Figure 4 to the right shows an isometric of the facility. The new Center for the Study of Educational Facilities would be adjacent to an existing Test Cell facility and the Research + Demonstration Facility, both of which would expand the research resource capabilities.

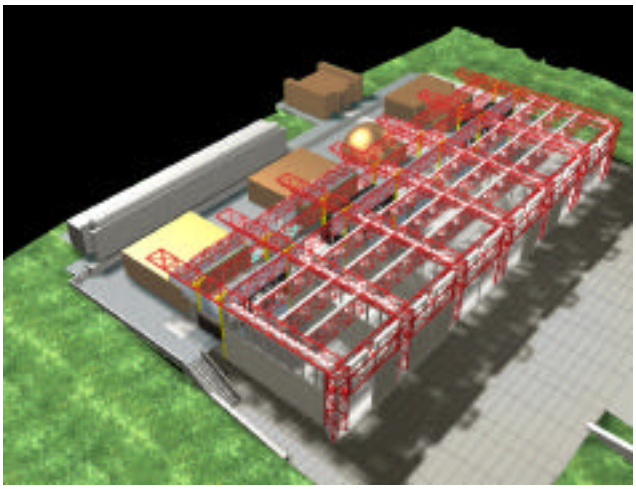


Figure 4. Isometric of proposed facility showing structural elements

Bibliography

American Institute of Architects Research, Committee on Architecture for Education Conference Report, http://www.e-architect.com/pia/cae/home2.asp

Educational Facilities Laboratories, SCSD: the project and the schools; a report, New York, 1967

Ehrenkrantz, Ezra, Architectural Systems, McGraw-Hill,1989

GAO, School Facilities: Profiles of School Condition by State, (Letter Report, 06/20/96, GAO/HEHS-96-148).

GAO, School Facilities: Condition of America's Schools, (Letter Report, 02/01/95, GAO/HEHS-95-61)

GAO, School Facilities: America's Schools Report Differing Conditions, HEHS-96-103

Design of the Blue Ridge Parkway: Environmental Masterpiece or Standard Road?

Mary Myers, Assistant Professor
Department of Landscape Architecture
College of Design
North Carolina State University
Raleigh, NC 27695

Introduction

The Blue Ridge Parkway has been touted as one of the world's most scenic and environmentally sensitive roads. (Newton, 1971) Is this really true?

The spectacular scenic qualities of the parkway, particularly its mountain vistas, are undeniable. However, it does not follow that environmental effects were insignificant. Sensitivity to view should not be equated with minimal environmental impact.

This study examines some broad impacts of the design on its immediate environment. The thesis is that the Blue Ridge Parkway is poorly located in portions of North Carolina and that this routing adversely impacted geology, soil and plant habitat. Some of the impacts were recognized and ameliorated through design. Others, such as destruction of rare plant habitat, were not correctable.

This view challenges conventional opinion that the Blue Ridge Parkway is a model of environmental road development. The paper also highlights areas of design strengths and weaknesses from which we can learn lessons.

Limitations of this study

It is beyond the scope of this paper to engage in a comprehensive assessment of parkway associated impacts. Like all roads, the parkway motor road fragments animal habitat and increases air and noise pollution. Likewise, this paper is not a quantitative assessment of environmental impacts along the lines of an Environmental Impact Statement. Instead it is confined to the *generalized* impacts and the design developed to ameliorate these impacts.

Location

The Blue Ridge Parkway, (1934-1987), is unit of the National Park Service. Unlike other units, it is a linear park, averaging 1,000' right of way, connecting two larger National Parks: Great Smokies National Park, Tennessee and North Carolina with Shenandoah National Park, Virginia.

Location, or overall route, was influenced by depression era politics with different states competing for the public works funds. Politicians and designers accepted that the parkway would pass through Virginia to access Shenandoah National Park. However, access to Great Smokies National Park could occur via Tennessee, or North Carolina and the two states competed vigorously for the $16 million in project funds.

In November 1934, after hearings and preliminary studies, Secretary of the Interior Harold Ickes decided upon a North Carolina route for the Blue Ridge Parkway, (BRP) which took it generally over the most scenic, and some would argue, the most vulnerable land in the Appalachian range. The area of greatest contention lay south of Blowing Rock, NC where the parallel ridges of the Appalachians are higher in elevation and take on a random configuration.

Potential construction and environmental problems did not go unrecognized by the landscape architects involved in early reconnaissance studies. A report on proposed locations reveals that Resident Landscape Architect, Stanley Abbott was not in favor of the crest route through North Carolina for reasons related to the monotony of scenery, dangerous driving conditions, costly construction, and perhaps most important, "scarring of the mountainsides." The report studied three potential routes for parkway: 1) the route lying wholly in Virginia and North Carolina 2) a route lying wholly in Virginia and Tennessee 3) a route lying in Virginia, North Carolina and Tennessee. Abbott's findings, based on five months of field study, recommended the third route for its "variety of scenery, reasonable construction costs and good direction." (Abbott, 1934*)*

Parkway cut through the Craggies Range

Higher ranking administrators of the National Park Service, including Arno Cammerer, Director of the National Park Service, supported Abbott's recommendation. But Ickes decided in favor of the North Carolina-Virginia location, perhaps because Tennessee already had considerable federal monies dedicated to the Tennessee Valley Authority. In any event, the 169 miles of parkway south of Blowing Rock, NC passed through the most rugged and untouched mountains of the east.

The steepest and most difficult section occurred near the southern terminus where the Plott Balsam range lay at right angles to the road. There the parkway crossed the mountain range perpendicularly. Ed Abbuehl, parkway landscape architect, described the topography as "almost impossible for parkway standards" and stated, " This road would create a scar visible for miles in the Great Smokies National Park…"(Abbuehl, 1936). Abbuehl recommended a longer, more gentle valley and foothill route but his recommendation was rejected. Instead administrators opted to achieve 'the impossible', get the parkway through the extraordinarily steep mountainous terrain between Soco and Balsam Gaps, just north of Great Smokies National Park. This location would also adversely impact rare plant habitat, (see below).

Impacts of Location on Geology

Blasting: The metamorphic and igneous origin of the Appalachians with cycles of erosion followed by a general uplift created numerous outcrops and areas where topsoil was very thin. The decision to locate in steep terrain required blasting to situate the road. In some places such as in Doughton Park, the road was literally notched into a vertical cliff. In others, it passed through subterranean passages. Blasting and excavation left strata and substrata exposed to erosion and weathering. The consequences were felt when excessive rains caused washouts and rock slides in September 1960, in Buck Creek Gap, NC.

Role of Gradient: Vertical gradient is related to location. BRP gradient had a significant role in environmental impacts. The designers followed established parkway precedent in insisting on gentle vertical grades conducive to a pleasant, safe and easy driving experience. A gradient of 3 - 6% became the BRP standard, with an absolute maximum of 8% for distances of ¼ mile or less. (Lord, 1954)

Achieving moderate gradient in naturally steep areas required drastic earth moving. Cut and fill would normally be balanced at a local level because cut could not be disposed of and fill could not be obtained other than through the road routing. Local

balancing increased volumes of earthwork in steep sections where the route encountered both ascent and descent. There was a 1,370' ascent and a 2,340' descent in the 12.5 miles from Soco to Balsam Gap. The massive excavation and blasting required to achieve gradient was understood by Abbuehl who questioned the purpose:"…the only accomplishment is to get from Balsam Gap to Soco Gap, which is a rather arbitrary control." (Abbuehl, 1936) Adherence to the gradient resulted in many tunnels. 24 tunnels had to be excavated in North Carolina south of Blowing Rock.

Steep Road Banks A problem in achieving moderate gradient in extreme topography is merging with existing grade. Cuts on the uphill side of the road and fill on the down hill side had to meet existing grade within the parkway right-of-way. This often resulted in extremely steep, unsightly and erosive banks, some in excess of 2:1 ratio. Parkway landscape architects struggled to try to blur the edge between road embankment and natural setting through planting but were not always immediately successful.

Impacts of location on erosion and watershed

The soils around the parkway were generally considered "immature" in profile. Slopes were acknowledged to be vulnerable to erosion, particularly where vegetative cover was weak. (BRP Master Plan, 1952)

For about a decade, until 1945, the parkway accepted erosion onto adjacent lands as a consequence of construction. A failure to reduce and disperse motor road stormwater caused serious erosion problems on private land holdings. Complaints were filed by adjacent landowners and supported by memoranda issued by the Soil Conservation Service. In 1944 it was estimated that half the drains along the parkway were causing "appreciable damage" to adjacent properties and that "no effort was being made to stabilize the gullies caused by parkway culverts, some as large as 10' deep and active." (Taylor, 1944) Drainage culverts had been located at regular intervals of 300 or 400 feet, regardless of the actual location of small streams and drainage ways. (Hooper, 2001). Inadequate for the velocity and volume of storm water the culverts directed all of the water from the road and the land above onto the low side of the road. After heavy rains water was ejected with such force that it gullied the land below, carrying away topsoil which filled nearby creeks and reservoirs. Parkway landscape architects, earlier critical of the impoverished and eroded mountain farm landscapes nearby, found themselves in a position of defending erosion!

Impacts of location on plant habitat

In the highest elevations, the parkway impacted a rare and sensitive plant habitat, the Spruce and Balsam Fir association found north and south of Asheville in the Craggies and Balsams. Much of this association was what the parkway administrators termed 'primeval' or virgin forest. Aside from the paucity of virgin forest anywhere in the east, the Spruce-Balsam Fir association was particularly unusual. It is indigenous to Canada and unknown in the southern U.S. except at elevations over 4,500. Road cuts impacted trees outside, as well as, inside of the motor road zone because of their shallow rooting structure, (due to thin topsoil). When the roots were cut the Spruce and Balsam Fir became vulnerable to blow downs and to disease. A warning against disturbing this habitat was issued in 1934 by Robert Marshall, wilderness advocate and friend of Ickes. Marshall visited the proposed parkway location and responded with a spirited memorandum to "Save the Primitive". He cautioned against building the road through the Pisgah, Balsam and Plott Balsam ranges of North Carolina due to the susceptibility of the trees to windfall after construction. (Marshall, 1934)

In 1938, the Acting Head of the U.S. Forest Service issued another warning against construction in the Spruce - Balsam Fir habitat. This time with specific data to confirm his recommendation:
"…severe damage to adjacent spruce and balsam fir stands inevitably follows right-of-way clearing. Recent studies made along the Newfound Gap-Clingman Dome's highway within the park showed

that more than 1200 trees bordering the right of way died or were blown down in a period of 21 months and a distance of 5 miles. In addition, a road cut through a dark coniferous forest is not healed for many years." (Forsling, 1938)

The advice, which referred to the Soco Gap-Balsam Gap section, was again unheeded. The motor road cut through stretches of Spruce – Balsam Fir habitat in the Plott Balsams and through the Craggies above Asheville. At least one major blow down occurred in the Asheville Watershed District during the 1940's. (Pease, 2001)

Design approaches to ameliorate geological impacts

Their location recommendations were ignored but BRP landscape architects could and did develop design approaches to reduce impact of the road. Moreover, the five decades of design and construction permitted time to observe, and in some cases, correct problems.

Single motor road of limited width:
The most important decision related to minimizing environmental disturbance was the single motor road with two lanes. Most parkways had divided motor roads with two lanes in each direction to facilitate a safer, more relaxing driving experience. Destruction caused by two motor roads in the steep North Carolina section would have doubled that of one.

20' wide parkway motor road with sloping rock adjacent to shoulder

The width of the motor road is narrower than most residential streets: 20 ' of paved surface with 5' grass shoulders on each side. The decision to maintain a narrow width reduced blasting and earthwork operations.

Detailing of Rock Cuts:
Rock cuts at the edges of the motorway were designed to try to relate to the natural slope of the mountain. Instead of the straight slice common to highways of the 1930's and 40's, the stone was cut to fold back into the mountainside. This would reduce slides and random stone fall. The stone walls were left quite close to the motorway sometimes as close as 5 feet from the edge of the road, a distance considered unsafe in standard highway situations. The decision to retain a limited shoulder zone reduced the amount of excavation. Often that which was left was imposing and added to the feeling of "naturalness" of the parkway. The presence of huge, battered, irregular stone walls within close proximity to the car may serve a safety function by inhibiting speed.

Use of advanced technology:
The final parkway section of the Blue Ridge Parkway was not completed until the mid 1980's. This section around Grandfather Mountain, el. 5637', was treacherous. Parkway landscape architects and engineers mulled over the problem for years, proposing different routes and road elevations. All involved what was by then considered to be an unacceptable level of environmental impact: blasting, filling, tunnel and retaining wall construction. Eventually, it was proposed that the road should follow the middle line of Pilot Ridge and straddle large rock formations. In one place, Linn Cove, the road became a completely elevated viaduct minimizing destruction of geology and vegetation. The type of post stressed, segmental, precast construction used for the viaduct was a technological innovation unavailable in the earlier years of parkway construction.

Design Approaches to ameliorate soil impacts

In late 1944, early 1945, BRP designers began to address areas of washout and gullying of adjacent lands resulting from improper dispersal of storm water. Field observation by teams of landscape

architects and engineers resulted in adjustment for pre-existing drainage ways. Problem areas were studied and additional culverts were installed, along with flumes, check dams and drainage ditches. In all areas, landscape architects directed engineers to keep water in its natural course, not to divert it. (Pease, 2001).

One of the most successful techniques for checking erosion over the long term was revegetating eroded areas. Experimentation with plants that could become established quickly, such as quick growing grasses and fescues, showed the designers that low growing species were often as useful in checking erosion as the taller ones preferred at the time. (Hooper, 2001)

Design approaches to ameliorate impact of plant habitat

Nothing could be done to correct the damage done to the old growth Spruce-Fir Balsam habitat. Parkway maintenance personnel utilized the downed wood for construction purposes. However, the serious impact to a very rare virgin forest type had been done.

Conclusion

What is to be learned from this analysis? First, that location is the foremost consideration of road design. The southernmost section of the Blue Ridge Parkway was located in an environment which probably ought to have been protected from *any* road development. Impacts to soils and watersheds were serious, the damage to plant habitat was irreversible.
Second, it is possible to ameliorate some road impacts over time. Observation, experimentation and adjustment of details are key to amelioration.
Third, design decisions, such as width of road, storm water accommodations and detailing of rock cuts can reduce environmental impact.

In the case of the Blue Ridge Parkway the corrective measures have been so cleverly accomplished and that the parkway is now considered to be a road without impacts.

Bibliography

Abbott, Stanley, June 8, 1934. *Report of proposed locations of the Shenandoah-Great Smoky Mountains National Parkway*, Blue Ridge Parkway Archives.

Abbuehl, Edward H., *Report to the Chief Architect on Reconnaissance of Alternate Line to Eliminate the Balsam Gap to Soco Gap, August 22, 1936.* Blue Ridge Parkway Archives.

Blue Ridge Parkway Master Plan Development Outline, March 1952. Blue Ridge Parkway Archives.

Crouch, J. Carlisle, 1960. *Memorandum to the Director of the NPS, October 12, 1960.* Blue Ridge Parkway Archives.

Forsling, C.L., 1938. *Memorandum for Mr. A.B. Cammerer, Director, National Park Service, October 10, 1938.* Blue Ridge Archives

Hooper, William O., 2001. *Interview with Mary Myers, January 6, 2001.*

Lord, William T., 1954. *History of the Blue Ridge Parkway.* Blue Ridge Parkway Archives.

Marshall, Robert, 1934. *Memorandum to Secretary Harold Ickes, August, 1934*. Blue Ridge Parkway Archives

Newton, Norman, 1971. *Design on the Land: The Development of Landscape Architecture.* Cambridge, Mass: The Belknap Press of Harvard University Press. p. 613.

Pease, Theodore, 2000. *Interview with Mary Myers, November 5, 2000.*

Taylor, O.B., 1944. *Memorandum for the Regional Engineer, May 9, 1944*. Blue Ridge Parkway Archives.

Recognition:
After this conference was completed, the ARCC board members in attendance voted two awards be made.

Shahin Vassigh, Assistant Professor, School of Architecture and Planning, at the State University of New York at Buffalo was given the "Best Presentation" award for her paper and demonstration of "Teaching Statics and Strengths of Materials using Digital Technology"

Jody Rosenblatt Naderi, Assistant Professor, Department of Landscape Architecture and Urban Planning, College of Architecture, at Texas A&M University was given the "Best Paper" award for her paper titled " Transportation + Street Trees: Effect of the Urban Design Industry's Roadside Landscape Improvement Standards on Driver and Pedestrian Performance.

Thanks:
It is important to recognize the people who contributed their time and insight to the success of this conference.

Professor Paul Knox, Dean of the College of Architecture and Urban Studies for his introductory remarks, and for hosting the welcoming reception.

Professor Frank Weiner, Head, Department of Architecture, College of Architecture and Urban Studies for his advice, and thoughtful introduction of Dr. Mayo.

Professor Walter Grondzik, ARCC Past President, from the School of Architecture at Florida A & M University, for chairing the peer review process for paper submissions.

Professor James Jones, Co-Chair for the Spring Conference at Virginia Tech.

Opening Speakers, Professor Volker Hartkopf, Director, Center for Building Performance and Diagnostics, Carnegie Mellon University and Professor Deborah Mayo, Department of Philosophy, Virginia Tech and discussion leader, Thomas Barrie, Professor, Department of Architecture, Lawrence Technological Institute.

Contributing Speakers, Matthew Nowakowski, Coordinator, Initiative for Architectural Research, Professor Dennis Jones and Mehdi Setareh, Department of Architecture, Virginia Tech and Professor Yvan Beliveau, Head, Department of Building Construction at Virginia Tech.

Professor Lucie Fontein, Carleton University, Conference chair for the upcoming 2002 ARCC conference May 22 - 25 at McGill University, Montreal.

I especially appreciate the following ARCC Board Members Participation in this conference.

Professor Mary Kihl, Editor ARCC Newsletter, from The Herberger Center for Design Excellence, College of Architecture and Environmental Design, Arizona State University

Professor James West, ARCC Secretary, School of Architecture, Mississippi State University

Professor Fatih Rifki ARCC Board Member, School of Design, North Carolina State University

And to all of the faculty and students who brought thoughtful papers and took part in the discussions, thank you very much. This would not have succeeded without you.

Last but not least, the dedicated graduate students that held transportation and documentation together: Ms. Patricia Nossen, Master of Architecture student, Department of Architecture Virginia Tech and Mr. Aaron West, recipient of the ARCC King Medal and Master of Science student at Virginia Tech.

Most sincerely,

Michael O'Brien, President ARCC
Conference Chair.

The ARCC Spring Research Meeting

Co-Sponsored by:

The College of Architecture & Urban Studies
at Virginia Tech

The Initiative for Architectural Research

Blacksburg, Virginia April, 2001






All Sessions in Donaldson Brown Hotel & Conference Center Rooms D & E

Table of Contents

The ARCC Spring Research Meeting
Co-Sponsored by:
The College of Architecture & Urban Studies
at Virginia Tech
The Initiative for Architectural Research

The Architectural Research Centers Consortium, Inc. (ARCC) is an international consortium of architectural research centers committed to the expansion of research culture and infrastructure in architecture and related design disciplines. Since its founding as a non-profit corporation in 1976, ARCC has exerted a concerted commitment to the improvement of the physical environment and the quality of life.

The ARCC Spring Research Meeting
Co-Sponsored by:
The College of Architecture & Urban Studies
at Virginia Tech
The Initiative for Architectural Research

Blacksburg, Virginia April, 2001

Sunday April 8

7:00 to 10:30 Registration

8:00 to 8:45 Welcome: **Paul Knox, Dean, College of Architecture and Urban Studies, Virginia Tech**

8:45 to 10:00 Opening Speaker, **Professor Volker Hartkopf: Director, Center for Building Performance and Diagnostics, Carnegie Mellon University**

10:00 to 10:15 Coffee Break

10:15 to 12:15 Session #1 I.T. and Bldg Management

Can a Machine Be Trained to Reliably Report the Operational Status of Building Equipment Systems through Simply Listening? And If It Can, So What?
Paul Woods, Hoonsik Seo, Ken Parker, Richard Burt, Emmit Coots, Zeena Pinto and Seongchan Kim, Texas A&M Univ.

How E-Commerce is Changing the Facility Management Practices of Building Owners
Robert Johnson, Mark Clayton, Jeong-Han Woo, and Ge Xia, Texas A&M Univ.

New Approach for Documenting Historic Buildings
Hussein Abaza & Yvan Beliveau Virginia Tech

12:15 to 1:30 Lunch on your own

1:30 to 3:15 Session #2 Env. & Sustainability

Transportation + Street Trees: Effect of the Urban Design Industry's Roadside Landscape Improvement Standards on Driver and Pedestrian Performance
Jody Rosenblatt Naderi, Enrique Serna, Byoung-suk Kweon, and Chris Ellis, Texas A&M Univ.

Managing Computer-Based Environmental Information
Jun Xu & James Jones Virginia Tech

3:15 to 3:30 Coffee Break

3:30 to 5:00 Session #3 Sustainability & Urbanism

Sustainable Urban Design for Asian Cities: Technological and Economic Concerns
Sivaguru Ganesan Univ. of Hong Kong

Making a Small Town Liveable: Promoting Sustainability Through a New Urbanist Approach in Mebane, North Carolina
Fatih Rifki, Umut Toker, Zeynep Genc-toker North Carolina State Univ.

Arcades: Investigating the Phenomena of an Urban Form
Nicholas B. Rajkovick & A. Kwok Univ. of Oregon

5:00 to 6:30 College Facilities tour

6:30 to 8:00 pm Deans Reception – Cowgill Hall Lobby
(see map on p. 44)

Monday April 9

8:00 to 9:00 **Dr. Deborah Mayo, Department of Philosophy, Virginia Tech, Author of "Error and the Growth of Experimental Knowledge"**

9:00 to 10:30 Session #4 Performance

Factors Leading to a Model Predicting the Compressive Strength of Concrete by Means of Its Sound-Transmission Properties
Emmit Coots/ Paul Woods, Richard Burt, Texas A&M Univ.

Thermal Comfort in Greek Revival Houses in Texas: A Computerized Energy Simulation
Anat Geva Texas A&M Univ.

Quicktime VR as a Tool for Teaching Visual Acuity
George Proctor Cal Poly Pomona

A Study of Preferences for Traditional and Modern Shopping Environments in Bangkok, Thailand: Preliminary Results
Apichoke Lekagul & Patrick Miller Virginia Tech

The ARCC Spring Research Meeting
Co-Sponsored by:
The College of Architecture & Urban Studies
at Virginia Tech
The Initiative for Architectural Research

Blacksburg, Virginia April, 2001

10:30 to 11:00 Coffee Break

11:00 to 12:30 Session #5 - Pedagogy

Applying a Constructivist Pedagogy to Design Studio Education
Matthew Powers VA Tech

Towards a Paperless Studio
Frederick Norman Ball State Univ.

Teaching Statics and Strength of Materials Using Digital Technology
Shahin Vassigh SUNY Buffalo

Ciao! Penn State: A Scaffolded Learning Environment
Darla Lindberg & Michael Halm Penn State

12:30 to 1:30 Lunch at Donaldson Brown
Doctoral Students discussion

1:30 to 3:15 Session #6

Research and the Studio:
Jim Jones Ph.D., Department of Architecture, Virginia Tech

IAR Research Database:
Matthew Nowakowski – IAR Initiative for Architecture Research

Integrating analysis with CAD design:
Dennis Jones & Mehdi Setareh Department of Architecture, Virginia Tech

3:15 to 3:30 Coffee Break

3:30 to 5:30 Session #7

Blobs, wiggles, folds and distortions
Gail Peter Borden North Carolina State Univ.

Research Ideologies, Information, and Moral Dilemmas
Frances Downing/Robert Warden Texas A&M Univ.

Rituals and Bodies in Spatial Re-Construction of Past
Reena Tiwari Curtin Univ.

Capturing Design Sites for the Web: A Comparison of Photos and Drawings for Place Recording
Nancy Cheng Univ. of Oregon

3:30 to 5:30 CAVE Facilities Tour

Tuesday April 10

8:00 to 10:00 Session #8

Architecture as a Knowledge-Based Tool: The Architectural Transformation of Workspaces
Fatih Rifki/Umut Toker North Carolina State Univ.

The Building of Research: A Center for the Study of Educational Facilities
A.J. Davis Virginia Tech

Design of the Blue Ridge Parkway: Environmental Masterpiece or Above Average Road?
Mary Myers North Carolina State Univ.

10:00 to 10:15 Coffee Break

10:15 to 12:15 Closing Session:

Research Methods and Architectural Curricula Roundtable: The National Affordable Housing Studio Initiative:
Matthew Nowakowski, IAR; Thomas Barrie, ACSA, Michael O'Brien, ARCC

The ARCC Spring Research Meeting
Co-Sponsored by:
The College of Architecture & Urban Studies
at Virginia Tech
The Initiative for Architectural Research

Abstracts: Session 1

Blacksburg, Virginia April, 2001

Can a Machine Be Trained to Reliably Report the Operational Status of Building Equipment Systems through Simply Listening? And If It Can, So What?

Paul Woods, Hoonsik Seo, Ken Parker, Richard Burt, Emmit Coots, Zeena Pinto and Seongchan Kim, Texas A&M Univ.

Purpose of the Research

The purpose of this research is to determine the system-wide reliability of the Acoustic Information and Retrieval System (AIRS); and if the reliability is good, describe the potential importance of this new data-acquisition system to architectural research.

Methods and Procedures

Digitally record representative acoustic events.
Prepare a training score for AIRS based on the digital recordings. For the purposes of this research, the term score means something akin to a musical score: a digital recording of a series of acoustic events.
Train AIRS.
Prepare a test score of randomized acoustic events.
Input the test tape to the AIRS acoustic pattern recognition engine.
After approximately 1000 replications, calculate the recognition rate.

Main Results

The experiment resulted in 1004 correctly recognized events and 11 incorrectly recognized events. This is a system-wide reliability approaching 99 percent under laboratory conditions. Field results can be expected to be somewhat less than this.

Status of the Effort

Implications for Architectural Research

In this experiment we chose to use the sound generated by plumbing fixtures as they were operated to exemplify an observable acoustic event. Even the ability to successfully observe these seemingly mundane phenomena has important implications to architectural research.

A review of the literature reveals that there is little or no empirical research on the actual use of bathrooms in the US. This is understandable given our socio-cultural bias toward extreme privacy when it comes to bathrooms. Can you imagine trying to get human-subject-committee approval for placing a video camera in a public bathroom or even standing around with a clipboard to make observational notes? I sincerely doubt it. So, this bias mitigates against actually observing how bathrooms are used; and without the ability to make observations, there can be no empirical

research. The key to acoustic observations of actual fixture operation is that it maintains personal anonymity while providing meaningful data on actual fixture use.

These data can be used to answer many architectural research questions. Here are four examples for a start:

What is the proper fixture-to-occupant ratio for different occupancy types?
What is the proper fixture-to-occupant ratio for different occupancy types based on sex?
Are certain fixtures of the same type used at a higher frequency in a given bathroom layout than others? If they are, what are the design implications of these asymmetric patterns of use?
What is the average time per use for different fixtures considering the sex of the user?

Future Work

We have begun live data collection on a seven-fixture men's room in a campus building. We expect to expand our coverage to three more men's rooms and then four additional women's rooms. Once the instrumentation is working reliably, we will begin data collection aimed at answering some of the research questions posed earlier in this paper.

How E-Commerce Is Changing the Facility Management Practices of Building Owners

Robert Johnson, Mark Clayton, Jeong-Han Woo, and Ge Xia, Texas A&M Univ.

Problem Statement

This research, which was supported by the IFMA Foundation Corporate Circle of Contributors, resulted from three observations. First, we have observed that use of the Internet and the World Wide Web has grown very rapidly, spawning often radically new ways of communication, collaboration and coordination among architects, engineers, contractors, and building owners. Second, it has been said that "Clients are the angels of invention" in the design and construction industry. Trends in our industry are often determined by the desires and programs initiated by large building owners. Third, despite the marketing enthusiasm of web-based "dot-coms," there was very little factual information about how the Internet was actually being used in the design, construction and facility management industry.

The ARCC Spring Research Meeting
Co-Sponsored by:
The College of Architecture & Urban Studies
at Virginia Tech
The Initiative for Architectural Research

Blacksburg, Virginia April, 2001

Goal

The purpose of this survey was to develop a rigorous and factual description of how e-commerce and web-based technologies were being utilized by large building owners (facility management organizations in Fortune 500 companies). Through this understanding it would be possible to speculate about the future growth of e-commerce throughout the industry. An additional goal of the study was to learn how and under what circumstances e-commerce achieves success or failure in facility management organizations. Such an understanding could provide guidance to organizations that are considering venturing into e-commerce applications.

Conceptual Framework

The conceptual framework adopted by this research was an outgrowth of our earlier research that explored the role of information technology in facility management. The basic premise in our earlier 1996 survey was that organizations adopt information technology in order to help achieve business goals. We used a similar premise in this survey, with the hypothesis that organizations that adopt e-commerce achieve improved performance (see Figure 1). This model represents the prevailing "conventional wisdom" in the industry. While there may be other factors that influence performance (e.g., leadership or marketing), our focus was on issues associated with the use of e-commerce. Based on previous research, we also hypothesized that those organizations that systematically improve work processes would have greater success incorporating e-commerce solutions. Other factors that might influence results were hypothesized to be issues associated with organizational context and characteristics of individual respondents.

Methodology

The method selected for this research was a mailed survey. Questionnaires were mailed in July 2000 to 1,714 facility managers from Fortune 500 companies who were also members of the International Facility Management Association (IFMA). The sample design was designed to reach respondents who tended to manage large, complex facilities and who were considered professional facility managers by virtue of their membership in IFMA. As of October 6, 2000, 578 usable questionnaires were returned, for a response rate of 33.7%.

Findings and Conclusions

The findings of this survey indicated that E-commerce was just beginning to emerge as a tool that is used to help manage facilities. Respondents had clear expectations that e-commerce in facility management will grow substantially over the next two years and that it will significantly affect facility management practices. The study also found evidence to suggest that those organizations that had adopted systematic methods to improve work processes were more likely to be early adopters of e-commerce.

New Approach for Documenting Historic Buildings

Hussein Abaza & Yvan Beliveau Virginia Tech

This paper discusses utilizing a 3D CAD measurement and modeling system for a historical building renovation. The 3D CAD measurement and modeling system (Vulcan – a product by Arcsecond, Inc of Sterling, Virginia) was used to generate three dimensional drawings of the Main Justice Building Court yard. The courtyard, which covers approximately 4,500 square meters is situated on top of a parking garage and is comprised mainly of stonework. The scope of the renovation work included salvaging the courtyard stone, demolishing and rebuilding the concrete structure of the car parking below the courtyard, and reinstall the salvaged stone back in its original location. Traditionally, a measuring tape would be used to document the vertical planes, and conventional surveying equipments are used to document the horizontal planes. In this project, the courtyard stone pieces are inherited in the building structure and some of the stones have unique three-dimensional configurations that cannot be surveyed by conventional techniques. Valcun was used to document the locations and the shapes of the stonework in the courtyard before removing it and demolishing the concrete structure. Vulcan has the ability to locate the required points in three- dimensional space. An integrated 3D CAD modeling system was used to generate 2D and 3D CAD drawings for the courtyard. These drawings were used to re-fabricate the dismantled stones, and to reinstall the salvaged stones in their original locations. The field surveying of the courtyard was completed in 16 working hours. More than 2000 stone pieces were located in the three dimensional space to an accuracy range of 3 mm.

The ARCC Spring Research Meeting
Co-Sponsored by:
The College of Architecture & Urban Studies
at Virginia Tech
The Initiative for Architectural Research

Abstracts: Session 2

Blacksburg, Virginia April, 2001

Transportation + Street Trees: Effect of the Urban Design Industry's Roadside Landscape Improvement Standards on Driver and Pedestrian Performance

Jody Rosenblatt Naderi, Enrique Serna, Byoung-suk Kweon, and Chris Ellis, Texas A&M Univ.

PURPOSE

The purpose of the research is to examine the affect of industry standard urban design treatments for streetscaping of Main Streets on traffic accident rates and pedestrian's perception of accessibility and safety. Existing research (Rosenblatt, Bahar) has indicated that the use of roadside landscaping is reducing traffic accident rates both in terms of frequency and severity. This paper identifies the next steps in research that is being developed at *** University which will create better understanding of the impact of specific streetscape design treatment on safety and accessibility. These standards will be evaluated for the effect on bicycle, pedestrian and wheelchair performance within the treated corridors.

The intention of the research is to provide the profession with quantitative rationale around the application of certain design guildelines to assure maximization of safety and accessibility for multi-modal corrdidor conditions subjected to standard urban design treatment. Pedestrian access will begin to explore the nature of standard landscape treatment on behaviour of pedestrians and bicyclists sharing the same transportation corridor.

METHODOLOGY

Utilizing "before-after" simulation of roadside landscape treatments, we will identify which type of landscape factors enhance driver behaviour through the use of the *** Transportation Institute's virtual simulator. Corridors will be created virtually, drive throughs will be performed by subjects, responses to events will be monitored through psychophysiographic measuring devices, eye-tracking, etc.

Determining the effect of the same treatment on pedestrians, wheelchair operators and bicyclists using the same industry standards will be measured through the use of the simulator where possible (in the case of the bicycles), and through the use of before-after imagery stills and videography. Using the physiological measuring devices of skin conductance, heart rate and eye tracking devices, the subject's reactions to changes in road side and boulevard conditions as he/she operates either a bicycle machine, a treadmill or an automobile will be evaluated in terms of response to events and quantified to determine the level of safety and accessibility achieved through each of the streetscape improvements.

MAIN RESULTS

There is enough evidence in the literature and in practice to indicate that the use of standard streetscape treatments (roadside landscaping, central median enhancements, street trees) in small communities across the United States and Canada is becoming as pervasive as engineering or architectural standards, especially since the funding opportunities created by Scenic highways legislation and TEA-21 have emerged. Unfortunately, designers do not have enough awareness of the effect of "streetscape" industry standards on driver and pedestrian safety and the application of the standards is lacking guidelines that address these issues. With FHWA releasing its new sidewalk and trail design guidelines, it is important to examine the multi-modal response to sidewalk, streetscape and urban design standards so that trade-offs within the curb lane and boulevard area do not compromise accessibility and safety of all users.

COMPUTER-BASED ENVIRONMENTAL INFORMATION MANAGING TOOL IN DESIGN PROCESS

Jun Xu & James Jones Virginia Tech

Environmental principles in architecture have drawn increasing awareness internationally. Various publications and studies have shown that these principles should be integrated into the design process. In this paper, we will explore the enhancement of managing environmental information with a possible computer-based tool for students and practitioners. The goals of such management include 1) emphasizing the integration of environmental issues into architectural design, 2) introducing combination of contemporary environmental principles and Feng Shui, and developing a computer-based tool for managing data and information.

The paper will focus on the consideration of environmental issues on architectural design. Both contemporary and traditional decision making will be considered. Conventional decision approaches such as those defined and analyzed by Olgyay, McHarg, and other researchers, emphasize western principles for basic aspects of the natural environment, including climate, physiography, hydrology, vegetation, and the life of the inhabitants. However, since these approaches are concerned with eliminating damage to the entire eco-system rather than to improve upon the life cycle of nature as many traditional techniques do, a combination of contemporary and traditional decision logic is needed. Following the simple observation that the environment influenced the decline or rise of civilizations, the ancient Chinese concluded that the energy or force of nature, Feng Shui, was essential to human life. So it is argued that design with Feng Shui principles can follow the natural law and can help to accumulate a good energy field, and eventually improve the life cycle of nature.

The ARCC Spring Research Meeting
Co-Sponsored by:
The College of Architecture & Urban Studies
at Virginia Tech
The Initiative for Architectural Research

Blacksburg, Virginia April, 2001

Therefore this research seeks to establish a combined analysis approach that may lead to a better understanding of the relation between humankind and the natural environment, and create harmony and equilibrium between them. This systematic viewpoint will be more useful and efficient when implemented into a computer-based analysis procedure using available web-based data sets, maps and aerial photographs, and an information technology approach. The implementation strategy can be found in the concept of a rule-based information system – a computational information representation system based on a structured database — where each rule is established based on both western and eastern principles.

The application of managing environmental information is helpful to enable students and professionals to learn and apply the knowledge in
the design process. The concept can also be used to create other architectural related systems such as constructional systems and HVAC systems. Therefore, each information system becomes a component in the whole process, and the incremental expansion of these sub-systems can be further developed into an integrated design decision-making system.

Abstracts: Session 3

Sustainable Urban Design Guidelines for Asian Cities

Sivaguru Ganesan *Univ. of Hong Kong*

The object of this research is to generate urban design guidelines for high-density Asian cities that respect a realistic resource base for design and construction. The paper uses data from completed case studies in Asia. The 1997 Asian economic crisis was a crisis in allocation of resources. Too much foreign debt was incurred and used on domestic projects which failed to generate adequate foreign currency revenues required for repayments. Many of these were construction and real estate projects in large urban locations such as Manila, Bangkok, Jakarta and Seoul in South Korea. The foreign exchange content in many urban ventures such as high rise office and commercial buildings, hotels, and luxury residential blocks reached up to 75% of total project cost; foreign liability was built up largely through commercial loans for project investments, and expenditures incurred through imports of finished materials and equipment, and imported raw materials and energy for domestic building materials production. Apart from increasing foreign debts, these projects also drained away valuable foreign exchange reserves in these countries, leading directly to a loss of confidence in local currencies, collapse of the exchange rates, a foreign exchange crisis and economic shrinkage. As a direct consequence, the construction sector experienced a massive decline in expenditure. The most important goals facing urban designers in Asian cities are to achieve a more balanced land use and built form in the high density districts, increase volume of infrastructure and housing construction, provide more efficient transport and reduce traffic congestion, reduce pollution of air, water and land, promote recycling of waste, build more energy efficient spaces and seek greater harmony with the ecosystem. Using mathematical models, the paper proposes that designers should adopt a technology that represents a prudent mix of local and foreign resources. Importing of foreign technologies, material and equipment resources will coexist with a mass of capital saving and labor intensive activities. For conventional mass housing and building sectors, development of a suitable building form based on such a mix of resources is indeed possible in theory; in practice, however, large scale training of skilled workers, expansion of domestic capacities for manufacturing of building materials, increased use of local raw materials in such units are the more important strategies that emerge from this research. The insurmountable challenge is posed by other construction sectors. Conventional technologies available within Asian countries cannot provide the technical know-how or construction capacity, required to solve these problems. Imported technologies that promise a solution appear to use too much foreign resources; design and construction based on such technologies are in the long term simply unsustainable. A total solution to these problems can only be the product of a national effort embracing strategies in all economic sectors. However , urban designers have to propose solutions that

The ARCC Spring Research Meeting
Co-Sponsored by:
The College of Architecture & Urban Studies
at Virginia Tech
The Initiative for Architectural Research

Blacksburg, Virginia April, 2001

optimize the use of foreign resources and bring about a sustainable resource base in urban construction, and enhance investment and building capacities, without leading the countries toward yet another Asian Crisis. This paper identifies critical areas for further research towards identifying more efficient guidelines.

MAKING A SMALL TOWN LIVABLE: PROMOTING SUSTAINABILITY THROUGH A NEW URBANIST APPROACH IN MEBANE, NORTH CAROLINA

Fatih Rifki, Umut Toker, Zeynep Genc-toker North Carolina State Univ.

A contemporary nexus of urban development discussions is the concept of sustainability, which is often presented as a viable remedy to many of the contemporary urban ills, i.e., diminished livability that is mostly blamed on suburban sprawl.

Not only large metropolitan areas experience sprawl. Numerous relatively small towns have been undergoing this kind of spatial transformation as their cores are emptied in favor of suburbs. Town of Mebane, North Carolina, is one such small town.

Today, downtown Mebane is home to manufacturing plants, retail stores, institutional buildings, and residences as well as empty lots and boarded-up buildings. Its architectural scale is still charming and its gridiron network of streets is capable of accommodating various modes of traffic although precedence is given to the car. Furthermore, some of the downtown buildings are worthy of consideration as historic landmarks, although many have been clad with metal panels, disguising their authenticity.

This paper is a progress report on the first of three phases of an urban design research project on downtown Mebane, being undertaken by *** University Architecture Faculty and Doctoral Students. The goal of the project is to generate sustainable urban development principles, guidelines and standards that promote urban livability. This phase involves an inventory of the town's physical, social, environmental and economical resources with New Urbanist "lenses" to develop specific sustainable urban development goals for the town's future and strategies to achieve these. In the subsequent phase of the project, proposals will be developed with citizens' input through citizens' charettes. It is envisioned that the process and the consequent proposal developed for Mebane is presented as a model to other small North Carolina towns that are striving to alleviate many of the ills of sprawl in the last phase of the project.

ARCADES: INVESTIGATING THE PHENOMENA OF AN URBAN FORM

Nicholas B. Rajkovick & Alison Kwok Univ. of Oregon

This work presents the findings of current research into urban arcades. This paper is the first in a series of three papers addressing the phenomena of urban arcades; a delightful design strategy employed in the built environment of cities. The paper focuses on the historical background of this building type, and the meaning of the arcade in history and literature through photo documentation and comparisons of urban arcades in northern temperate climates. A subsequent paper will address the physical properties of a series of arcades through analysis of light, sound, and thermal conditions. A final paper will document the human factors and behavioral patterns of this building type.

As an urban strategy, arcades are a strategy that divides city blocks into a skylit promenade, collecting businesses along an interior path. In architectural history, the arcade has acted as both a pedestrian thoroughfare and home to retail, a linear space with defined beginning and end. Many terms in English describe buildings of this type, borrowing freely from foreign languages. Terms such as cité (Belgium), bazar (Hungary), and galleria (Italy) are common, all describing arcades. However, arcade, as a direct translation of the German durchgang or French passage, best describes this building type as a “through” place, a transitional series of spaces implying movement.

Arcades are transitional spaces, or internal arteries that connect two or more external streets. Transitions through various types of thresholds are common as pedestrians move from street to street, or from sidewalk to interior shop. The arcade is a small, enclosed city, connecting shops with a unique microclimate and street life. As a communal thoroughfare, these internal streetscapes are an idealized urban type. The strategy of the arcade serves to protect pedestrians, moderating temperature, light, and wind. As a typical design, the Cleveland Arcade (Fig. 1) accommodates tight, symmetrical frontage, and collects shops in a density higher than typical outdoor streets. In this way, arcades are both the street and city, knitting shops in conditions nominal for year-round retail.

How an arcade maintains a suitable environment for retail will be discussed through a series of examples, all of which are located in northern temperate climates. Topics such as local climate, height to width ratio, amount of glazing, and typical pedestrian patterns vary building to building, providing a point of departure to investigate the spaces. Three examples of arcades that will be discussed and compared are:

The ARCC Spring Research Meeting
Co-Sponsored by:
The College of Architecture & Urban Studies
at Virginia Tech
The Initiative for Architectural Research

Blacksburg, Virginia April, 2001

The Cleveland Arcade in Cleveland, Ohio

The Colonial Arcade in Cleveland, Ohio

The Galleria Vittorio Emanuele II in Milan, Italy

This first paper will show how arcades have played an important role in the cultural and urban fabric of our cities, and how they have functioned in literature throughout history. As background, this research will lead to an understanding of this type in our urban environment, and provide lessons for future design of such spaces.

Abstracts: Session 4

Factors that May Lead to the Prediction of the Compressive Strength of Concrete by Means of Its Sound-Transmission Properties

Emmit Coots/ Paul Woods/Burt *Texas A&M Univ.*

Purpose of the Research

Design and fabricate a test stand for use in these laboratory experiments.
Calculate descriptive statistics for each variable.
Using one-way ANOVA, determine if the variability within any of the proposed study variables appears too high.
Perform a t-test to see if there is a significant treatment effect due to any of the proposed independent variables.

Methods and Procedures

Prepare two concrete test cylinders of different compressive strengths
Cure cylinders to ultimate strength.
Place each standard concrete cylinder on the test stand
Secure an Acoustic Information Retrieval System (AIRS) sensor to the cylinder,
Generate a controlled, repeatable sound by the impact of a steel object on the concrete cylinder.
Digitally record the acoustic signal produced by the impact.
Repeat this test for a total of 30 replications for each cylinder.
Obtain measured values for the following independent variables: event duration, peak amplitude, minimum RMS power, maximum
RMS power, average RMS power and number of peaks.
Destructively test the cylinders to determine their compressive strength.
Perform a t-test to determine if there is any significant treatment effect on the dependent variable, compressive strength, due to any of the independent variables.

Main Results

The test stand was used to collect data for the study. Although it is heavy and difficult to move about (we'll include photographs, etc in the full version of the paper), it is excellent for laboratory use.

The statistical analysis resulted in the following:

The descriptive statistics suggest that some of the proposed independent variables may have too great a variability to be of use. Of course, this is definitively tested in the One-Way ANOVA below. The One-Way ANOVA showed that none of the proposed independent variables exhibit internal variability at a level that would

The ARCC Spring Research Meeting
Co-Sponsored by:
The College of Architecture & Urban Studies
at Virginia Tech
The Initiative for Architectural Research

Blacksburg, Virginia April, 2001

suggest they should not be used in future analysis. This result was obtained at a 95% level of significance. The t-test shows that at least one of the proposed independent variables exhibits a treatment effect between the two concrete cylinders. This result was obtained at a 95% level of significance. This is very promising in that the difference in compressive strength between the two cylinders is only 200 psi according to standard, ASTM testing procedures.

Status of the Effort

The results of the current study pave the way for our next experiments. In the next project we will test the compressive strength of five concrete cylinders per day for 30 days. The test will consist of recording five impact events per cylinder and then immediately destructively testing the cylinders on a hydraulic press to measure the compressive strength of each cylinder. Statistical analyses will then be performed to determine if the compressive strength of the concrete cylinders can be predicted by any subset of the proposed independent variables we measured in this current experiment.

CLIMATIC COMFORT IN GREEK REVIVAL HOUSES IN TEXAS: A Computerized Energy Simulation study

Anat Geva ***Texas A&M Univ.***

The literature acknowledges the Greek Revival style as a reflection of politics, socio-economic status, and fashion, and describes the style as one of the firsts in a succession of national styles that attempted to erase the regional boundaries previously marked by vernacular architecture. However, the relationship of the Greek Revival style and regional climatic conditions that determined the extent of comfort in these houses usually appears merely as an observational note. The objective of this paper is to fill the limited empirical basis by examining how Greek Revival houses responded differently to regional climates. Specifically, the study posits that Greek Revival houses of the 19th century are more compatible with the hot-humid climate of southeast Texas than with the cooler climate of the northeast where this style originated.

In pursuing this objective the study analyzes two pairs of 19th century Greek Revival houses. Each pair consists of one house originally constructed in Texas and the other constructed in New York. The selection of the sample houses was based on stylistic similarities, the construction period, the climatic regions, and the availability of Historic American Buildings Survey (HABS) drawings and pictures. The study tested the extent of the compatibility of the style with each specific climate utilizing a multi-method approach that incorporates a qualitative morphological

analysis and a quantitative empirical methodology of computerized energy simulations. The climatic comfort and energy performance of each house was analyzed twice. First, using the actual conditions of the specific sites in Texas or New York. Second, using virtual (simulated) sites, as if the houses of Texas were "transplanted" to the other location in New York, and the ones in New York to the Texan location.

The findings support the research proposition and introduce an additional angle to the study of nineteenth century Greek Revival houses in the south of the United States. It shows that in the south, this style represented not only the influences of politics, status symbols, and fashion, but also became a rational response to regional climate. These findings suggest an additional explanation of the popularity of this style in the south.

Finally, the paper discusses several methodological implications of the utility of a multi-method approach to increase validity of findings, and the rigor of computerized simulations as means to test hypotheses and concepts of environmental theories in the context of history and place.

QTVR as a Tool for Teaching Visual Acuity

George Proctor ***Cal P****oly Pomona*

Purpose

The ability to discriminate fine details when looking at something is visual acuity. In the context of this project visual acuity refers to a keen ability to visually recognize color, contrast, pattern, line, texture, form and space, composition, and perspective from an image or visual field.

To build visual awareness and notational skills, design pedagogy typically makes use of images, verbal descriptions and provides training with abstract notational systems for relating images with words. Using language to direct a student's visual skills clearly has limitations. "Language does not fulfill the semantic requirements of notationality because the meaning universe of language is chock-full of ambiguity, redundancy and other necessarily blurring features." (Gardner 1982 p.67) In addition, while many students do recognize principles described in abstract diagrams, it is a language unfamiliar or new to a majority of entry level students. Students uncertain of the semantic and syntactic functions of a graphic notation system, which is a new language to many of them, struggle to translate data freely from work to notation and back to work.

If building visual acuity is fundamental in a design program, this project seeks to develop tools for making immediate and direct connections between what to see,

The ARCC Spring Research Meeting
Co-Sponsored by:
The College of Architecture & Urban Studies
at Virginia Tech
The Initiative for Architectural Research

Blacksburg, Virginia April, 2001

beginning with how it is naturally seen (perspective), with its terminology (verbal & graphic). With the advent of digital technology, the connection between image and notation can be made very direct. This project seeks to build visual acuity by using QTVR panoramas to train the student's eye from the perspective view combined with a superimposed verbal/graphic notational system.

Methods & Procedures

For this study, a series of interactive panoramic images were created at locations on our campus physically accessible to students. These interactive panoramas will be used to help students: 1.) Identify what to look for 2.) Validate what and how they see and 3.) Provide a graphic notational system for representing what is seen. Students can be sent to the locations, and asked to identify a collection of visual elements and retrieve their results through sketch, graphic and verbal notation. Subsequently students can be shown the interactive panoramic movies from the same locations.

The interactive panorama (Quicktime VR) has a capacity to accommodate a correlation between a real world perspective image and an abstract notational system. The QTVR interactive movies developed for this project flag visual elements and introduce graphic notation (e.g.-sun paths, orientation, descriptors) over the elements of a scene and in addition, have been combined with enhanced of visual information (e.g.- fields of color, contrast, texture). This assemblage will enable students to verify visual elements from the location visited on campus and to make comparisons between visual elements as they pan around at a specific node.

Status

All of the data used in this teaching and training tool is pre-captured. An underlying assumption is that the content of this project may be combined with the technology being developed in the science of pattern recognition. Research presently being developed in pattern recognition was investigated as a reference. However, this project is not about the technology (hardware, software/algorithms) of pattern recognition. The mechanical process and sequence followed to create the individual panoramic movies may eventually provide the foundation for planning and organizing a software application. The project is presently under development and will be implemented in 2001.

A Study of Preferences for Traditional and Modern Shopping Environments in Bangkok, Thailand: Preliminary Results

Apichoke Lekagul & Patrick Miller Virginia Tech

Traditional shopping environments have long been an important part of Thai culture, providing for the economic, social, and psychological needs of people. However, the introduction of western-style shopping environments, a result of the globalizing economy has changed this. These well-planned shopping malls provide a variety of products, services, and facilities in clean and comfortable environments, however they may be lacking for certain types of social interaction. Traditional shopping environments, although still in existence, remain undesigned and seem to provide only certain products to limited groups of people. In order to preserve this important part of Thai heritage, architects and planners should need to understand preferences and behaviors of Thai people toward shopping environments.

The purposes of this research is to; 1) identify relationships between environmental factors and preferences of Thai shoppers for different shopping environments, their shopping habits, and their backgrounds; 2) provide design recommendations for traditional shopping environments to enable them to survive in the new economy, especially in terms of opportunities for social interaction and recreation in shopping environments. Factor analysis of preference data was used to identify important underlying environmental factors. Behavioral and demographic data were analyzed using MANOVA to identify further relationships between different types of shoppers and environmental factors.

The results of this research suggests that there are perceived differences between different types of shopping environments and that these differences relate to opportunities for social and recreation activities as well as shopper needs. These differences are related to the time of day that people shop, the length of shopping visit, the age and level of education of the shopper and family shopping habits.

The results of this research suggest that the physical environment of traditional Thai shopping environments could be modified to preserve their viability by making then more preferred and to attract wider range of shoppers. Recommendations from this research include:

1. Preserving the existing perceived and preferred characteristics, such as fresh and specialty products, low and negotiable price, convenient access, and full interaction of products and sellers.

2. Enhance quality by keeping the environments clean and, somewhat organized, especially display areas, and provide sufficient circulation spaces.

The ARCC Spring Research Meeting
Co-Sponsored by:
The College of Architecture & Urban Studies
at Virginia Tech
The Initiative for Architectural Research

Blacksburg, Virginia April, 2001

3. Increase comfort by providing small-scale structures and enclosures for protection against the weather, and providing vegetation to increase the aesthetic quality, as well as providing shade and cooler temperature.

4. Provide opportunities for recreation and social interaction by including sitting areas and entertainment, such as cultural events.

5. Provide seasonal festive elements such as small and detailed signs, and colorful decorations.

Abstracts: Session 5

Applying a Constructivist Pedagogy to Design Studio Education

Matthew Powers *Virginia Tech*

The actions of teachers and learners are not necessarily guided by an overt knowledge of the reasoning behind them. Intuition, successful experiences, and observations: these factors play an important role in influencing the behavior of teachers and, no doubt, often dictate their practice. Educators often adopt and utilize a particular approach or method without necessarily having purposely considered the theory or philosophy that underpins it. This paper is important because it helps to guide the development of a philosophical framework unconsciously employed by many design teachers already. Specifically those teachers that without knowing the term or having been informed of the theory are already providing students with opportunities for constructivist learning. This paper reiterates von Glaserfeld's (1995) comments: "constructivism does not claim to have made earth-shaking inventions in the area of education; it merely claims to provide a solid conceptual basis for some of the things that, until now, inspired teachers had to do without theoretical foundation."

This paper will apply constructivist pedagogy to teaching and learning in the design studio. First, the paper will provide some meanings associated with constructivism followed by the changes in worldview that has effected the development of constructivism as a way of knowing. Next, the paper discusses constructivism's implications for education and defines two variations of it, radical constructivism and social constructivism. Finally, ten pedagogical principals suggested by constructivists will be listed and related to the design studio. The main goal of this paper is to use constructivism as a framework for reassessing and redesigning the process of constructing knowledge that is inherent in teachers, learners, and the studio system itself.

Forms of constructivism, as a philosophy of knowing, have emerged and reemerged throughout human thinking and debate since at least Ancient Greece. Constructivism in education generally holds that knowledge is subjective, truth is relative to individual experience, and reality is actively created and changing. Constructivist proponents within education have fostered areas of theory leading to several different constructivist-style approaches and movements. These approaches include radical constructivism, social constructivism, cognitive constructivism, information-processing constructivism, and other such topics and approaches. This paper will focus on radical constructivism and social constructivism because of their appropriateness in the development of a pedagogical framework that can be applied to design studio education.

This paper will combine radical and social constructivism to develop a list of ten considerations regarding constructivism in the design studio. These considerations

The ARCC Spring Research Meeting
Co-Sponsored by:
The College of Architecture & Urban Studies
at Virginia Tech
The Initiative for Architectural Research

Blacksburg, Virginia April, 2001

relate to: 1) establishing prior constructions of knowledge, 2) formative assessment and evaluation, 3) student negotiated studio goals, 4) creation of authentic problems, 5) creation of a rich studio environment, 6) emphasizing big concepts and interconnectedness, 7) encouraging multiple presentations and representations, 8) consideration of errors as opportunities, 9) teacher and learner roles, and 10) teaching methods. The ten considerations will be further explained through a case study of a design studio where many of these ideas were tested. Educators will learn a constructivist pedagogical perspective that they may choose to utilize in their own classrooms and studios with the hopes of creating more constructive learning processes and environments.

Towards a Paperless Studio

Frederick Norman *Ball State Univ.*

Digital media has altered the process of design and the culture of design education. The infusion of digital media into the practice of architecture is changing how we design as well as what we design. The question one must ask, is how do we transition from an analog system of representation to one of complete computer immersion or the "paperless studio"? Integrating digital media into a traditionally manual world of design inquiry has become its largest obstacle. How do we make this transition and how will digital media provide opportunities beyond traditional forms of representation?

The use of digital media and computers are finding their way into studios everywhere but the physical integration of new media (infrastructure and economics) may be the simplest issues to resolve. The integration of new media now becomes a pedagogical concern. The traditional skills of communication and representation i.e., sketching, hand drawing and physical model making, are being challenged by new media and its forms of representation. The paradox facing architectural practice today is the integration of new media into a realm where traditional or manual forms of representation are ingrained into how we think, produce and communicate. Will new media be held to the traditional forms of representation? This problem of integration will be the focus of this discussion as one considers the possibility of the "paperless" studio in the years to come.

Changes in practice as well as design education should look to new media particularly modeling and time-based media with the opportunity for further exploration of our ideas, the creation of new forms, and a new vocabulary. The creation of new forms comes with a responsibility of seeking new forms of representation.

tural practices should look to digital media as a means of exploration in areas of conceptual modeling to understanding material transitions. What obstacles do we face and how do we reach a point of fully digital investigations? What if anything will be lost once we achieve the "paperless" studio? To answer these questions we must begin to build a knowledge base in the area of digital media if we look toward the future of a paperless studio. This paper will briefly examine three types of computer software used in architectural schools and practices. Next we will look at the integration of digital media followed by the problems facing communication and representation digital media in an area dominated by traditional methods of presentations. Lastly we will look at how to incorporate this knowledge base into the studio culture through the use of workshops, electives, and curricular changes.

Teaching statics and strengths of material with digital technology

Shahin Vassigh *SUNY Buffalo*

Developing innovative approaches to education is not unique to architecture, but as the technical component of a creative degree program, developing innovative approaches to the teaching of structures within the architecture curriculum is not only desirable, but absolutely necessary. The fundamental problem is that although understanding structure lies at the core of the education of the architect, architecture faculty and students struggle with a traditional engineering-based approach to structures instruction, which is increasingly proving to be ineffective in the classroom.

The traditional engineering based approach to teaching structures is largely a product of the historic development of scientific thinking, the evolution of the engineering discipline and the changing role of architecture. The growing role and influence of the engineer within the design and construction of the built environment has lead to the introduction of sophisticated mathematical models into the building construction process. As a result the scientific method and mathematical rationalism have become the dominant models for teaching structures to both engineering and architecture students.

Architecture students have very different educational needs, technical capabilities and will apply structural design principles differently than engineering students and professional engineers. The unfortunate mismatch between structures curricula across the country and their students has a fundamental problems. The instruction based on engineering approach is highly quantitative, communicating even basic concepts using an advanced mathematics nomenclature however, the architecture students have neither the background, disposition, nor time to master the mathematics skills required to understand or utilize a system based on highly mathematical models. They, therefore quickly become uninterested, frustrated, or even intimidated by the

The ARCC Spring Research Meeting
Co-Sponsored by:
The College of Architecture & Urban Studies
at Virginia Tech
The Initiative for Architectural Research

Blacksburg, Virginia April, 2001

Architecstructures curriculum.

This paper will discuss the nature of the problems inherent in current teaching approaches to structures and will outline the framework for the development of an alternative pedagogy and instructional delivery system based on the use of digital technology. Using computer-generated models, interactive images, and animation, this alternative seeks to integrate the quantitative engineering methods with the qualitative approaches using a range of digital visualization devices to better meet the architecture students' needs and measurably improve the understanding and application of basic and advanced structural engineering principles.

The article will describe how the alternative tool can augment quantitative approach to teaching statics and strength of materials with quantitative and conceptual approaches. Specifically the use of digital technology in the introduction of concepts such as vector analysis, two force members (truss and cable), stress, strain, and moment will be explored.

The central underlying principle for the development of this alternative teaching tool is to provide a highly visual and direct means of communicating concepts and grounding them experience. It is anticipated that by using powerful graphics, animation, and other means of visual communication, an intuitive base for the understanding of the structural concepts can be well established and strengthened.

Ciao! ***: A Scaffolded Learning Environment

Darla Lindberg & Michael Halm *Penn State*

"Designing a building, an urban development or an industrial project is not just contingently but fundamentally a collaborative, interdisciplinary, geographically distributed, multimedia activity."

William Mitchell, MIT School of Architecture and Planning

Ciao! *** is the result of a research project funded by the Center for Excellence in Learning Technologies. Its intent is three-fold: first, to look at the study of architecture through the design studio model as an opportunity to enhance multidisciplinary undergraduate learning; second, to extend this learning model through information technologies to form virtual organizations and communities, to our foreign program in Rome, Italy; and third, to develop a prototypical model that has far-reaching implications for resident instruction and continued professional development and practice.

The design studio is considered by some as one of the most effective learning

models. In general, the traditional design studio model, when successfully implemented, effectively incorporates cognitive, metacognitive, social and affective learning strategies into its delivery. In effect, students learn through a constructivist project orientation in a reflective, collaborative and mentored environment. The criticism of this model is that it fails to seek broad multidisciplinary perspective in the design process similar to that necessary in professional practice. This is not due to a flaw in the model but in the availability to expert resources and geographic constraints. The challenge, then, is to develop a model that extends beyond traditional architectural instruction, so that it might include a multidisciplinary focus and have broader implications for the higher education community (Boyer and Mitgang, 1996).

The result of the research to be presented with this paper is a web-based resource intended to "scaffold" a fifth year thesis project in architecture. GIS, CAD, VRML, Web chat, video conferencing, intelligent agents, multimedia databases and dedicated WWW servers are a few of the technologies that have been employed. It was the goal of this research project to incorporate a variety of new and emerging technologies to link support course content (including experts from around the world, past student project archives, study guides, etc.) as "scaffolded" to the thesis design studio course. The test site has been the thesis student at the home department of *** with implications for the foreign study program in Rome, Italy, and the world campus. The hope is to enable the varied, idiosyncratic problem of a student's thesis topic to guide the support course material. In this way, the delivery of support course material is not linear, general, and separate from the thesis, but linked directly to the specific process of a student and problem of his/her thesis. Results are beautiful and suggest even larger implications for continuing education or collaborations between university and industry design teams.

The ARCC Spring Research Meeting
Co-Sponsored by:
The College of Architecture & Urban Studies
at Virginia Tech
The Initiative for Architectural Research

Abstracts: Session 7

Blacksburg, Virginia April, 2001

blobs, wiggles, folds and distortions

Gail Peter Borden *North Carolina State Univ.*

The ability to work within a system is the foundation of all social interactions. Rules establish the boundaries. Dave Hickey, the noted art critique, songwriter and brilliant perceptionist of contemporary culture, illuminates the ability for rules to liberate the individual by sustaining the parameters within which one must re-invent oneself to advance the group. Hickey proclaims that basketball, as the most democratic of all sports represents the quintessential framework for liberation. Dr. J and his under-over behind the back shot allowed for a deflecting re-invention of the sport of basketball. An understanding of the system allows the parameters to define a way to overcome their limitations by turning back into the fold to use the system against and ultimately for, itself. Digital technologies provide the moves in architecture.

The machine subscribes to a system. As a production of man, it employs simple Euclidian geometries to construct its rationality. The conventional computer, (as the primary interface with the digital other-side), establishes a technological disjunction. The body, as our mediator to the world, similarly displaces the mind from reality. Limited by ten digits, a prescribed language, its fracturing based on the secondary system of the alphabet, and a numerological translation to a series of ones and zeros, the digital maintains a foundation in semiotic delineations. Thus meaning derives from a contextual stance of relation.

Digital space is dependent upon this association. Text is more than any single entity. The grouping of letters into words, and words into sentences inhibits the disposal or fissure of any component. When translated to the digital, the fissure is expanded due to manual dexterity. The result is a variant system between the flow of the mind and the stasis of the machine establishing a mental lag between the expressions of the soul and ether manifestations. Man and mind, mind and machine remain ever disparate.

The balance between the system and the product emerges out of the individual. Chuck Yeager, in his treatise on dog fighting, speaks about the relationship between man and machine. The cyborg is the hybrid, created when man enters into a union of both body and mind with the intricate technologies of the vastly complicated airplane. The necessity is a simultaneity that allows for the individual to push ones anatomy and the machine's engineering to the maximum. At this extreme edge, the two become one as the cognitive shuts down defaulting to the instinctual. The merger allows for the individual to stop flying the plane and rather "fly the bullet." This synthesis is essential in the foundations of digital interface. Conception emerges out of a system unseen to the mind or operator and hybridized by the limits

of conception and the extremities of technology.

This text and images represent conceptualization impossible without digital technology. Though their calculations and geometries could be manually recognized, their ability to adjust and transform are dependent upon a reactionary time. The previous limitations of their precision and calculation prevented their employment. Digital media has re-invented the standards by accelerating the rules.

Research Ideologies, Information, and Moral Dilemmas

Frances Downing/Robert Warden Texas A&M Univ.

Research in Architecture and related disciplines has always suffered from dueling Western oppositions of objective/subjective, universal/ particular, eternal/temporal, global/local, and the ultimate/immediate. [1] We have Ph.D. students who want to do measurable, "objective" studies of things or phenomena. At the same time we have students who want to understand human conditions from a more internal and "subjective" worldview. The shape of procedures and the resulting information that research ideologies fashion (tables, matrixes, categories, equations, hierarchies, hermeneutic discourses, critical essays, or allegorical conclusions) offer different levels of credibility but present a wonderfully complex view of a "knowledge-based" discipline.

The tensions between dueling positions are never resolved definitively in research ideologies even when "middle" positions are invented. We train students to have a valid, viable question and a consistent argument; the credibility of information, we say, is tied to its logical base…how are the question, inferences, backing and conclusions related, while, at the same time, keeping ideological roots clear. Our Ph.D. students have benefited from a review of research ideologies—their statements about what it is they want to know, how they propose to gather data, and how they will interpret this information have improved immensely from exposure to a full range of research ideologies.

Oppositions are black and white; reality, for our students, is quite gray. As a result of "educating" our students in Western research ideologies we have often created more paradoxical positions then clear answers. We sometimes find students trying to "add-up" two or three positions (put one foot in this camp, then stretch to put their other foot in another, and perhaps a hand over here), as a result of their own desires to have a consistent view for their whole existence. They begin our class with a fair idea of the question they want to ask. By the time we are through reviewing research ideologies—the huge difference that evolutionary theories have made and the debate

The ARCC Spring Research Meeting
Co-Sponsored by:
The College of Architecture & Urban Studies
at Virginia Tech
The Initiative for Architectural Research

Blacksburg, Virginia April, 2001

between self and community —some are paralyzed between personal, internal ethics and values and the research question they have posed. Four positions emerge:

The student continues to hold their private beliefs as separate from their research question and continues to hone the research question they started with.

The student cannot hold one set of beliefs for their personal worldview and another for research ideology—complicating their research question with conflicting goals.

The student tries to find a "middle" position (the best of both worlds) through redefinition.

The student has a consistent worldview/research ideology.

Much like our students, we have no one answer to the conundrums that naturally exist between personal goals and research goals. We have begun to mitigate some of these difficulties by introducing critical issues of "scale of nature" and applicable theory. [2] Scale refers to the research question and its boundaries—does the question refer to a limited time period (the blink of a lifetime) or a relatively immense period (the "laws" of nature). Applicable theory, then, becomes a barometer of the degree to which evolution or physics enter the project. Most of this narrows the scope of the research questions to one of how much the "change-over-time" effect the projects—guiding them in a qualitative or quantifiable direction. Another way to look at the problem is to define "systems" more carefully. If a student takes a "mechanical" view of systems, then quantifiable knowledge of the workings of a system is possible. If a student takes an "internalist" view of systems then there is a tendency to try to discover the self-organizing, dynamic, and autonomous nature of existence—thus leading to a more "interactive" approach to research. Neither view is "wrong" but simply yield different information.

Rituals and Bodies in Spatial Re-Construction of Past

Reena Tiwari Curtin University. Australia

Hyper-real environments (shopping malls, theme parks) signify the emergence of mass society where the style (signifier) is separated from substance (the signified) (Benjamin, 1969). This has led to the "the death of the subject" (Baudrillard, 1983) and raises the question of our occupation of a real or represented space.

This postmodern habit of borrowing from the past or from mass imagery shows our dissatisfaction with the present and nostalgia for the past and leads to an invention of context and meanings? This approach also highlights our total preoccupation with

the visual. It leads to picking up elements from the past devoid of their meanings and placing them as objects in space.

A new approach is called for, “an approach which would not analyse things in space but space itself, with a view to uncovering the social relationships embedded in it”(Lefebvre, 1991,p. 89). We have also to move away from compartmentalization of space where different ideologies divide space according to the social division of labor (Lefebvre, 1991).

This paper thus brings in an interdisciplinary approach towards analyzing space. Examining the interrelationship of the space with the rituals as well as the bodies, which, not only occupy space but also produce it, does this. Here, the space is viewed as a process.

If we look at the phenomenon of the search of a lost identity, recreation of the past, reconstruction of a recognizable environment based on a nostalgic past, we find that it is not true for the contemporary city alone. This has been carried on for centuries in some of our very old cities. Varanasi (2500 years old) in India is such an example. Here residents construct their Lord’s city every year, based on a 16th century text, through rituals. My aim is to see how the performance becomes a mediator between the textual and the physical space leading into the construction of social space. Are there any codes in the physical setting which are picked up by the mind during the performance, which then help in the creation of a social space?

I agree with Lefebvre that social space can not be seen as a container of different objects. It can not be reduced to a “‘form’ imposed upon phenomena”(Lefebvre). It is revealed only when the mental space becomes indistinguishable from the physical space. This is what the simulated environments fail to achieve and become ‘realer-than- real’. Christine Boyer mentions the city, as “work of art”, “ spectacle” or “panorama” (Boyer, 1994). This again emphasizes her emphasis on the visual. On the other hand, the city spaces could well be seen as a backdrop for rituals. They could be created as inter-linked stages, where the participant moves from one to another as per his/her role. This enables the individual to have the space imprinted in mind due to the intense relationship of the body with the space. Rituals help in transferring the participants to a liminal phase, where they start seeing the past in the present scene. This is not the evocation of a past environment as in the case of theme parks, but produces a palimpsest where the individual is able to feel the tension between the past and the present.

The ARCC Spring Research Meeting
Co-Sponsored by:
The College of Architecture & Urban Studies
at Virginia Tech
The Initiative for Architectural Research

Blacksburg, Virginia April, 2001

Capturing Design Sites for the Web: A comparison of photos and drawings for place recording

Nancy Cheng *Univ. of Oregon*

Understanding the spirit of a place is important for generating a site-responsive design. By visiting a site, a designer collects information about physical, social and cultural conditions while perceiving nuances that may shape design direction. Tools for recording a place can shape understanding by focusing attention. This paper documents how designers uses cameras and sketchbooks and compares resulting Web pages. It is part of an effort to understand how site information can be gathered and synthesized for remote collaboration.

Creating virtual Web places stimulated an interest in enlivening computer graphics with the richness of nature. This provoked the questions: What technology can help us look at the world in a thoughtful way? How can each media’s limitations and possibilities be combined to give us the strongest field toolkit? Traditional site analysis, virtual navigation and concepts of place influenced the project.

The study includes two trials of site visits followed by web authoring. One group of students spent a day recording the spirit of place on a rural site using cameras OR sketchbooks (Topography was already documented). Another group captured place information independently at different sites. Images interpreted for the websites were tallied according to medium (camera vs. sketch), scale of image (vista, forms, textures) and content (formal order, natural forces, cultural meaning and human activity).

Initial results showed more photographic vistas and more sketching of forms and textures. Observed process trade-offs include speed of recording vs. deliberateness of subject choice, number of sketches vs. detail of sketches, ease of recording vs. ease of editing. The paper discusses the difficulty comparing different sites and assignments and explains how data can be considered to accommodate these differences.

This study begins to document how tools affect field recording of visual data and insights. Seeing how available tools influence process can shape development of new tools. Next steps are other comparisons, i.e. video vs. still digital, pen-based computers vs. paper sketchbooks and the inclusion of audio note taking. The study is a prelude to using laser-measuring, photogrammetry or image-based modeling and rendering (IMBR) techniques. The long-term goal is to refine an effective toolkit and methodology for capturing essential site information.

Abstracts: Session 8

ARCHITECTURAL TRANSFORMATION OF WORKPLACES: FROM INDUSTRIAL REVOLUTION TO INFORMATION AGE

Fatih Rifki/Umut Toker ***North Carolina State Univ.***

It is a rarely disputed contemporary truism that, at present, workplaces, particularly office buildings, are major drivers of urban development across the world. For example, in the U.S., office construction has become one of the vanguards of the building industry, as it has come to make up close to a sixth of all new construction. Therefore, it is not surprising that workplaces, as a major element of architectural typology in the 20thCentury, are fast becoming a significant concern for architects.

As more offices are being built, the nature of work continues to change, particularly with the advent of the "information age" demanding new concepts in managerial sciences to be developed for efficient functioning of workplaces. The ubiquitous digital equipment, i.e., personal computers, that process vast and ever increasing quantities of information is the latest factor of change in the nature of office work and is therefore requiring a new approach to managerial organization in work environments. It is only natural that these developments, both the nature and management of work, continue to demand new and distinct architectural design approaches. These approaches extend from the urban design scale of technopoles that facilitate congregation of similar workplaces for "synergy" and "creative milieu" to building component scale where fresh alternatives of spatial structure that more effectively respond to the new work flow in the workplace.

It would not be far-fetched to note that building workplaces goes as far back in history as building shelter for habitation. As a matter of fact there is ample evidence that distinct workplaces, similar to contemporary notion of office, have been built in ancient Egypt. Nevertheless, emergence of offices as a significant building type coincides with the Renaissance and gathers unprecedented momentum with the Industrial Revolution. As the human society and its economy moves from production to service centered industry at the end of the second millennium, workplaces are evermore omnipresent.

This paper traces the architectural transformation of workplaces from the Industrial Revolution to today in response to changes in nature of work including technology used, and developments in managerial sciences of work. The aim of this study is to uncover how new managerial concepts introduced and developed in response to the changing nature of office work influenced the architectural design of this building type. The paper concludes with informed speculations of appropriate architectural responses to these trends in the near future.

The ARCC Spring Research Meeting
Co-Sponsored by:
The College of Architecture & Urban Studies
at Virginia Tech
The Initiative for Architectural Research

Blacksburg, Virginia April, 2001

THE BUILDING OF RESEARCH: A Center for the Study of Educational Facility

A.J. Davis *Virginia Tech*

This paper will focus on the program and development of a research facility for the study of education related facilities. This facility will represent on-going research as well as provide the means and space for environmental studies into issues affecting primarily K-12 educational facilities. It is intended to provide a laboratory level climate control chamber, full-scale mock up space with adjacent data acquisition equipment to monitor a full compliment of environmental conditions and occupant response. Numerically controlled construction capabilities and rapid prototyping tools will be provided to facilitate spatial reconfiguration of full-scale mock-up spaces. The shop areas would include mockup capabilities in wood, metal and fiberglass. In addition, a day lighting dome for model studies, space for future and on-going research grants and necessary classroom and office space to augment all the current operations will be provided. Not only will the building be able to advance these research concerns, it too will be an on-going study investigating optimized building envelope designs. In addition, it will feature photovoltaic arrays on north facing skylights and provide cooling through natural ventilation. The facility will be primary agents for the execution of grants with targeted agencies such as the National Science Foundation (NSF), Housing and Urban Development (HUD) and the Department of Energy (DOE). The facility will also provide unique opportunities for collaborative projects between industry, the College and partnering universities.

The facility shown above [see below — wg] is intended to provide a research focus into all architectural, engineering and environmental concerns facing K-12 educational facilities. We feel this facility to be complimentary to another State institution, the Jefferson Center at *** that focuses on pedagogical issues of K-12 education, by focusing on the issues affecting the renovation of existing facilities and the design and construction of future schools. It is estimated that this State will spend in the next two decades, billions of dollars renovating and building new primary and secondary public school facilities. This research will be invaluable to that effort and would help elevate academic research centers to the national forefront as leaders in research affecting the physical environment.

This paper will further discuss the potential of targeted research to service one of the most critical of our public institutions. It will discuss the impact of technology integration, energy cost reduction, indoor environmental quality, contractual relationships between school boards and architects and engineers, of 'fast-track' processes on construction, mechanical and electrical equipment installations and the on-going decline in attention to natural ventilation and day lighting concerns. These issues, and more, would be studied in a comprehensive context addressing interrelationships between issues.

Design of the Blue Ridge Parkway: environmental masterpiece or above average road?

Mary Myers *North Carolina State Univ.*

Was the design of the Blue Ridge Parkway based on sound aesthetic and environmental principles or is it overrated as a well-planned road? The Blue Ridge Parkway (1934-1987) is a narrow strip of parkway corridor owned and administered by the US National Park Service. Begun as a Public Works Project, the parkway was designed and built through the heart of eastern Appalachia. It has been touted as one of the country's most scenic and environmentally sensitive highways. However, does its design truly serve to support its natural context? This investigation seeks to understand more about the design goals, processes and results of the parkway in order to objectively assess its merits or shortcomings.

Methods used to address the topic include archival research related to Blue Ridge Parkway specifications, memoranda, drawings and reports in order to understand the underpinnings of the design. Interviews with landscape architects and soil scientists associated with the early days of the parkway are being conducted to better understand the design and construction process. A survey of the naturalists and rangers who maintain and interpret the parkway has been undertaken in order to understand current management and conservation issues.Field study of a section of parkway, in Smart View, Virginia, is ongoing and eventually will illustrate the evolution of the parkway conservation and management policy.

Preliminary investigation, (undertaken over the past two years), suggests that the parkway landscape architects initially stressed scenic considerations, such as, view from and of the road; over ecological concerns. Design objectives were later broadened to acknowledge plant,animal and soil conservation in response to the criticism of biologists and foresters. Landscape specifications were altered in the late 1930's to encourage forest regeneration and wildlife habitat on parkway lands. Data and interviews provided by current wildlife and plant biologists will help us to understand the consequences of these alterations. Archival documents describe soil stabilization techniques for erosion prone wetland areas. Field investigation will demonstrate the successes and failures of these techniques.

Archival research and oral history is virtually complete for the project. Interviews and field research are in the beginning stages. This presentation will summarize the findings to date and indicate the direction and shape of future research.

Roads are a planning legacy of the American twentieth century. The constituent elements of the design methodology used for the Blue Ridge Parkway are worth consideration and evaluation as techniques that may be applied to present needs.

The ARCC Spring Research Meeting
Co-Sponsored by:
The College of Architecture & Urban Studies
at Virginia Tech
The Initiative for Architectural Research

Blacksburg, Virginia April, 2001

Roads are a planning legacy of the American twentieth century. The constituent elements of the design methodology used for the Blue Ridge Parkway are worth consideration and evaluation as techniques that may be applied to present needs.

College of Architecture & Urban Studies Research Centers

The Community Design Assistance Center (CDAC)
The Community Design Assistance Center assists communities, neighborhood groups, and non-profit organiazations in improving the natural and built environments through design, planning, policy, and research. Through the integration of the learning and working environments, the Center will execute projects that link instruction and research and share its knowledge base with the general public.

Elizabeth Gilboy, Director
Community Design Assistance Center
100 North Main Street (0450)
Virginia Tech
Blacksburg, VA 24061
http://www.lar.arch.vt.edu/program/CDAC/default.html

International Archive for Women in Architecture (IAWA)
The International Archive of Women in Architecture is a joint program supported by College of Architecture and Urban Studies and the University Libraries. It was first conceived in 1984 as a place to record women's contributions to the built environment and to ensure their place in history, filling a void in the historical record of women's achievements in design. It consists of documents that record and reveal many forms of theory and practice, including architectural drawings, photographs, office and project files, correspondence, exhibit panels, manuscripts, essays and articles, brochures, and biographies.

Marcia Feuerstein, Chair
Assistant Professor of Architecture
Board of Advisors, International Archive of Women in Architecture
Department of Architecture
College of Architecture and Urban Studies
Virginia Tech **http://spec.lib.vt.edu/iawa/**

IAWA Website for information about the Bliznakov Research Prize
http://spec.lib.vt.edu/iawa/BlizPrize.html

The ARCC Spring Research Meeting
Co-Sponsored by:
The College of Architecture & Urban Studies
at Virginia Tech
The Initiative for Architectural Research

Blacksburg, Virginia April, 2001

College of Architecture & Urban Studies Research Centers

Henry H. Wiss Center for Theory and History of Art and Architecture
Humberto Rodríguez-Camilloni, Ph.D. Professor
Director
Department of Architecture
Virginia Tech.
http://www.caus.vt.edu/CAUS/International/FLW/FLW.html

The School of Public and International Affairs (SPIA)
The School of Public and International Affairs (SPIA) supports the university's mission through its instruction, research, and public service programs. The School's mission is to focus Virginia Tech's excellence in policy and management issues to help communities across the world understand and resolve some of their most critical problems. Only five years old, the School has already established new interdisciplinary programs that address critical issues facing communities and organizations in different cultural settings.

Director
James R. Bohland, Ph.D., Provost, Virginia Tech.
Department of Urban Affairs & Planning
http://spia.arch.vt.edu/

Institute for Public Policy Research
The mission of CPAP's Institute for Public Policy Research is to serve the Commonwealth by providing research and consultation on important issues of public policy and to provide opportunities for Virginia Tech graduate students to participate in significant research activities. The Institute pursues this mission through research and technical assistance projects sponsored by local, state, and federal governments, nonprofit organizations, and other enterprises.

Renee Loeffler, Ph.D. Director
CPAP / IPR
7504 Haycock Road
Falls Church, Va.
http://www.nvgc.vt.edu/ippr/

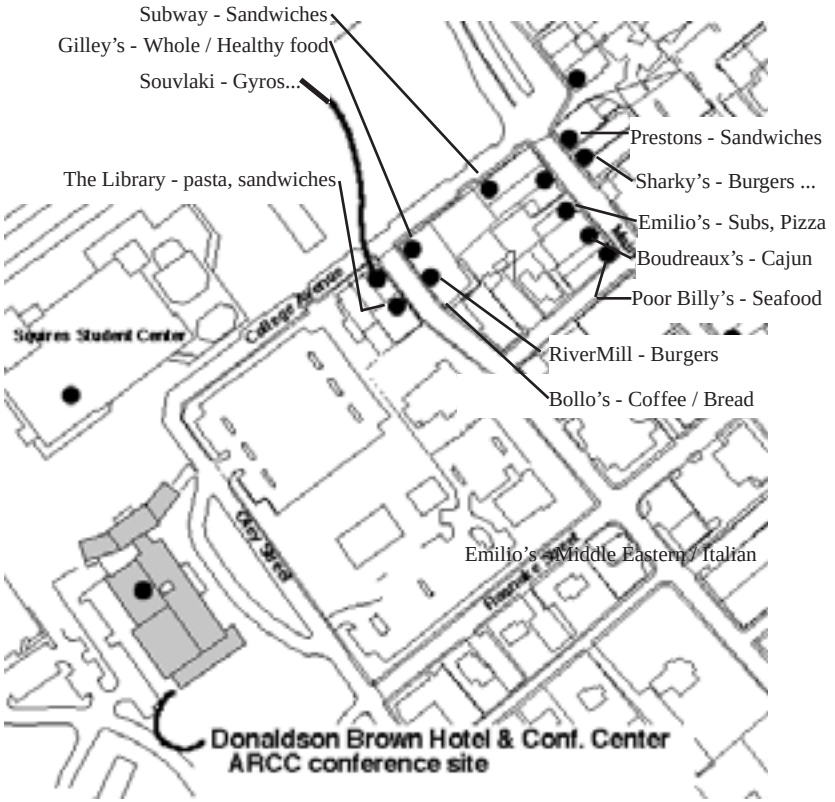
Center for Preservation and Rehabilitation Technology
Humberto Rodríguez-Camilloni, Ph.D. Professor
Director
Department of Architecture
Virginia Tech.

Blacksburg, Virginia April, 2001

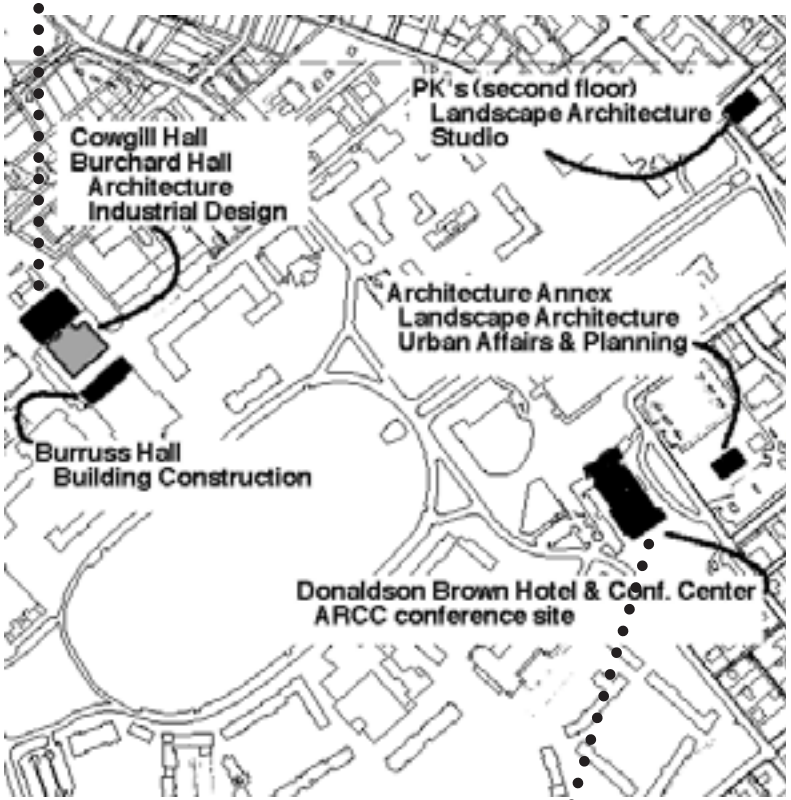
Center for Preservation and Rehabilitation Technology
Humberto Rodríguez-Camilloni, Ph.D. Professor
Director
Department of Architecture
Virginia Tech.

The ARCC Spring Research Meeting
Co-Sponsored by:
The College of Architecture & Urban Studies
at Virginia Tech
The Initiative for Architectural Research

Blacksburg, Virginia April, 2001



Cowgill Hall
(reception site)



Donaldson Brown
(conference site)

The ARCC Spring Research Meeting
Co-Sponsored by:
The College of Architecture & Urban Studies
at Virginia Tech
The Initiative for Architectural Research

Blacksburg, Virginia April, 2001

Conference Co-Chairs:	James Jones, Ph.D., Assistant Professor, Department of Architecture, Virginia Tech Michael O'Brien, Associate Professor, Department of Architecture, Virginia Tech
Papers Review Chair:	Walter Grondzik, Professor, School of Architecture Florida A & M University
Packet Design	Susan Molesky, Assistant Professor, Department of Architecture, Virginia Tech

The ARCC Spring Research Meeting
Co-Sponsored by:
The College of Architecture & Urban Studies
at Virginia Tech
The Initiative for Architectural Research

Blacksburg, Virginia April, 2001

The ARCC Spring Research Meeting
Co-Sponsored by:
The College of Architecture & Urban Studies
at Virginia Tech
The Initiative for Architectural Research

Blacksburg, Virginia April, 2001

By signing this form I agree to allow this paper prepared for the Spring 2001 ARCC conference to be published on the ARCC website and have obtained permissions as required to publish any copyrighted material herein.

Signed _____

Printed name _____

Date _____