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# Changes of Paradigms

## in the basic understanding of architectural research

## Architectural research and the digital world

eaae | arcc conference
copenhagen 2008

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## VOLUME#1

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## VOLUME 1

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# #PREFACE

The Royal Danish Academy of Fine Arts, School of Architecture, in Copenhagen had the honour of hosting the EAAE/ARCC 2008 conference entitled "Changes of Paradigms in the Basic Understanding of Architectural Research. Architectural Research and the Digital World."

The conference took place from the 25th to 28th June 2008. A number of 140 attended the conference including paper authors, 36 from the USA and Canada, the rest from all over Europe: Iceland, Finland, Norway, Sweden, Denmark, the UK, Ireland, the Netherlands, Germany, Austria, Switzerland, Belgium, France, Italy, Spain, Portugal, Greece, Hungary, Romania and Turkey.

**Excerpts from the conference introduction**

Today it is clear that digitalisation has opened a path leading to new forms of representation and new opportunities with regard to developing and handling highly complex spatial and surface forms. But digitalisation has also made new interactive forms of communication possible which could give the architect a new role and a new social position – thereby supporting the claim that architecture and architects are now facing a revolution which is as radical as the Renaissance.

The question is whether we who are involved in architectural research have managed to understand these new conditions and help the potential revolution on its way – and this is the main topic of this research conference.

Another aspect of digitalisation is the revolution in communication forms and control systems with global effects to which it has led. We have created a form of global simultaneity: we can control financial transactions in new ways, and we can control globally divided production processes in ways which have meant that some phenomena and processes apparently only exist in the virtual world, and that both financial issues and culture are released from the geographical spaces with which we normally associate them in our understanding of the world. This constitutes a radical change in the contextual frameworks in which we normally place architecture and architectural production.

Even though this will probably be challenged by some people, it is nonetheless still possible to claim that architecture only exists in an analogue world – that architecture as space and materiality in relation to human senses and bodies does not take shape as architecture until it has been completed.

This makes the question of the relationship between the digital and the analogue worlds a central issue for architectural research.

This is not an obscure and overlooked field: many of the theorists of globalisation have stressed that the processes of globalisation and the digital world do not acquire real meaning until they 'touch the ground' – that the necessary infrastructure belongs to the analogue world, and that the messages transmitted in the digital networks are produced in the analogue world. In other words, the digital world and the analogue world are closely interwoven.

However, some of the theorists of globalisation and digitalisation have pointed out that understanding and awareness of this interwoven relationship constitute one of the major problems facing researchers. There is a tendency among both researchers and commentators to place themselves either in the digital world or in the analogue world – but rarely do they focus on the

vital meeting between these two worlds, regarding the way in which the two worlds interact and determine/deform each other's logic.
The other key question at the conference focused on the massive challenges within the profession posed by the almost explosive growth of population and cities and the related issues on how to develop models for sustainable urban development.

**5 keynote speeches and 51 papers presented on two days**

Five different keynote speeches and 51 papers were presented at the conference. Due to the many papers and their length it has been necessary to divide the proceedings into two volumes that we have entitled: "Day 1" and "Day 2".

**The first volume: "Day 1",** contains two articles related to the keynote speeches of Saskia Sassen and Marvin Malecha that deal with more general reflections on the conference theme. Additionally meteorologist Jesper Teilgaard had been invited to shed light on the advanced use of digital models in a different professional setting. In this volume all the papers from the first paper session day, the 26th June are presented. Sessions A: Theories and Sessions B: Production and Process.

**The second volume: "Day 2",** contains two articles relating to the keynote speeches of Jens Kvorning and Volker Buschers talk on the Arup project in Dongtan, China. In this volume all the papers from the second paper session day, the 27th June are presented. Sessions C: Analysis and Visualization and Sessions D: Architectural Education and Visualization.



We want to thank all the persons involved as well as the paper authors and conference guests for their participation in the conference.

On behalf of the organizing committee

**Ebbe Harder**
The Royal Danish Academy of Fine Arts
School of Architecture
Denmark

**J. Brooke Harrington**
Temple University
ARCC Liaison
USA

Per Olaf Fjeld
President EAAE

# Changes of paradigms in the basic understanding of architectural research

The title of the conference implied two important aspects; that there is a clear collaboration between the two associations and that architectural research as a discipline is still searching for an identity and a content of its own. Equally the need to find clarification around what is architectural research and what is its direction is an essential issue for both architectural education and the profession. In the midst of Copenhagen at its best, a beautiful and vibrant city in June, the Royal Danish Academy of Fine Arts, School of Architecture hosted the event with great generosity and flare. The program was ordered and well prepared, and the content was presented in four basic sessions: Theories, Production and Process, Analysis and Visualization, Architectural education. Each session had suitable moderators with ready questions they directed towards each of the presented papers, thus a more intense and precise discussion evolved within each session. Since several sessions took place at the same time, one was not able to attend all. This was unfortunate in that many had very interesting discussions, and it was inevitable that the final summing up would lack each particular session's atmosphere and intensity.

Though quite different in content and direction, the keynote lectures also indicated the breadth and scope of the topic, and the language that supported opinions and ideas was not homogeneous. There is no consensus in relation to social or environmental issues, but rather diffuse transformation through many interpretations. It also became clear that "urban" has an increased complexity and scale that is extremely difficult to comprehend and discuss as a plenum. This awareness is influencing one's ability to read and comprehend what it is to understand a new paradigm. This is also true for architectural research. Its complexity extends beyond individual meanings or interpretations, as it lies within multitude of larger systems shaping an invisible order. The connection between a physical visual order and the digital order is not fully understood, but at the same time the situation indicates many things can no longer be coded in the same manner as earlier. Architecture is evolving into far more of an infrastructure capable of taking on a variety of spatial and functional programs, than the actual physical edifice. In this light, critical thinking becomes an essential instrument in a research based architectural education. Is it this rather diverse identity that must be understood as architectural complexity?

These rather difficult concerns and questions were raised throughout several of the lectures, but perhaps approached or discussed in different ways. As always, Dean and professor of architecture from North Carolina State University, Marvin Malecha was very clear and straight forward: “traditional structure does not work any longer… and in a recent survey 86% of the clients ask for research based design”. He went on by saying that 97% believe that clients will find value in research based design. If these numbers are somewhat accurate, then schools of architecture need to sharpen their content towards a stronger focus related to research by design. We have to be clearer in our comprehension of research; on what we do and the way we do it, such that the content also has the ability to strengthen the core within the built architecture, that is architecture itself. Over and over lectures emphasized the need for schools to actively navigate towards future change, to strengthen reflective and inventive capacity.

In that each session approached the topic from a specific position or area of interest there was room for all the participants to experience a stimulating discussion. It was a great pleasure to take part in the event, and equally that so many attended the conference from the USA. Clearly the relationship between the two associations is important. Our challenges are global. Better communication and understanding among one another is essential when facing the challenges ahead.

Many thanks to Ebbe Harder and his staff for an excellent arrangement, and to Dean Sven Felding for hosting us and all our questions. Thank you very much.

**Michel Mounayar**
President, Architectural Research Center Consortium (ARCC)

# Design knowledge

International collaboration is critical for academics and scholars. The Architectural Research Centers Consortium (ARCC) is keen to promote and continue vigorous collaboration with the European Association for Architectural Education (EAAE). Our international conferences have been a symbol of excellence and collaboration among architectural researchers and scholars. The important factor, of course, remains the assembly in a single place where some of the most influential architectural researchers unveil their recent works.

In July of 2008 the special place was Copenhagen! Copenhagen is a most suitable and symbolic location for a serious examination of design and design knowledge. The city embodies the eternal values of fine design rooted in tradition, social justice, and sensible use of resources. We are truly grateful to our host the Royal Academy of Design and most specifically Dr. Ebbe Harder and his staff, especially Anne Katrine G Gelting and Pia Davidsen. Your hospitality touched us all. We will forever have fond memories of the stately dinner collectively shared at the Carlsberg Glyptotek Museum of Art. We are also grateful for the warm reception and beautiful venue provided by the municipality of Copenhagen, as our thanks also go to all participants, paper authors, paper reviewers, editors, and other technical and scientific committee members for their priceless contributions to the success of this conference.

“Changes in Paradigm in the Understanding of Architectural Research” is an influential conference for the diverse work it featured from numerous European and U.S. universities engaged in thoughtful and relevant research anchored by new and innovative subjects, methodologies, and data gathering techniques. A unique session format was also introduced to keep the conversation focused and stimulating. Each session moderators were asked to supply a set of critical questions for the presenters’ spirited reaction and treatment. These questions provided for hearty discussion. The tone and tenure of the conversation were enriching and provocative especially the special keynote speeches that reminded the gathering of the growing challenges of an identifiable knowledgebase for and of “Design”. Architectural design must be supported by innovative and informed databanks that substantiate the art of special creation, the complexity of human habitation, the wonder of materiality, the deviance of climate, and the functional mitigation of the program. The variables are infinite and require the consorted efforts of all, both in academia and in industry.  Some questions seem to linger still unanswered, including: How can designers practice in the present complex world without the support of reliable evidence? What is the role of research in the process continuum of design and architecture? What subject matters are important to our profession? Who should fund architectural research?

The keynote address by Saskia Sassen alerted the gathering to recent global dynamics and their influences on new media-rich environments that defy traditional definitions of the vibrancy of urban centers resulting in the unlikely supremacy of emerging new information hubs.  Dean Marvin Malecha, president-elect of the American Institute of Architects and the initiator of our joint ARCC and EAAE international conferences also in his keynote address argued the importance of realizing the inherent existence and the need for a clear and growing architectural knowledgebase.  His keynote message also implied, optimistically, the need for structural review of architectural education as it holds the core potential integration of practice and research.

The conference rigor also netted a full complement of paper sessions dealing with the multipart range of these important questions. Presentation topics were diverse ranging from the core elemental such as syntax and vocabulary, to the intricate and quantifiable such as the use of acoustical calculations and highway noise attenuation. This richness is evident in the collection of papers featured in these proceedings. However perhaps the most important success of the conference is the continued promise and commitment of future collaboration and partnership between the combined membership of EAAE and ARCC.

# #KEYN

# NOTES

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# Why cities matter

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Saskia Sassen

# Why cities matter

By the mid-twentieth century, many of our great cities were in physical decay, losing population, losing economic activity, losing key roles in the national economy and losing their share of national wealth. As we move into the twentyfirst century, cities have re-emerged as strategic places for a wide range of projects and dynamics. This essay explores the whys, the hows and the whats of this shift. It does so through the economic, architectural and political dimensions of cities. These are briefly described below before entering into the inevitable sea of details.

Critical and partly underlying all the other dimensions, is the new economic role of cities in an increasingly globalized world and the associated architectural and technical revolutions this has entailed. The formation of inter-city geographies is contributing a critical infrastructure for a new global political economy, new cultural spaces and new types of politics. Some of these inter-city geographies are thick and highly visible: the flows of professionals, tourists, artists and migrants among specific groups of cities. Others are thin and barely visible: the highly-specialized financial trading networks that connect particular cities depending on the type of instrument involved, or the global commodity chains for diverse products that run from exporting hubs to importing hubs. These circuits are multi-directional and criss-cross the world, feeding into inter-city geographies with both expected and unexpected strategic nodes. For instance, New York is the leading global market to trade financial instruments on coffee even though it does not grow a single bean. But a farless powerful financial centre, Buenos Aires, is the leading global market to trade financial instruments on sunflower seeds. Cities located on global circuits, whether few or many, become part of distinct, often highly-specialized intercity geographies. Thus if I were to track the global circuits of gold as a fi nancial instrument, it is London, New York, Chicago and Zurich that dominate. But if I track the direct trading in the metal industry, Johannesburg, Mumbai, Dubai and Sydney all appear on the map. Looking at globalization through the lens of these specificities allows us to recover the particular and diverse roles of cities in the global economy. Each of the cities profiled in this Biennale is part of particular global circuits. Many others not profi led are on such circuits as well, as is indicated, for instance, by the fact that the top 100 global service firms together have affiliates in 315 cities worldwide.

While many of these global circuits have long existed, what has begun to change since the 1980s is their proliferation and their increasingly complex organizational and financial framings. It is the new challenge of coordinating, managing and servicing these increasingly complex, specialized and vast economic circuits that has made cities strategic. It is perhaps one of the great ironies of our global digital age that it has produced not only massive dispersal, but also extreme concentrations of top level resources in a limited number of places. Indeed, the organizational side of today's global economy is located and continuously reinvented, in what has become a network of about 40 major and not-so-major global cities; this network includes most of our 16 Biennale cities. These global cities must be distinguished from the hundreds of cities that are located on often just a few global circuits; while these cities are articulated with the global economy, they lack the mix of resources to manage and service the global operations of firms and markets.

The more globalized a firm's operations and the more digitised its product, the more complex its central headquarter functions become and hence the more their execution benefits from dense, resource-rich urban environments. In global cities, then, the interaction of centrality and density takes on a whole new strategic meaning: physical density is the urban form, housing an increasingly complex set of activities for the management, service, design, implementation and coordination of the global operations of fi rms and markets.

Architecture and civil engineering have played a critical role in building the new and expanded urban settings for the organizational side of the global economy. This is architecture as inhabited infrastructure. Let me explain. The much talked about homogenization of the urban landscape in these cities responds to two different conditions. One is the consumer world, with homogenizing tropes that help in expanding and standardizing markets to the point that they can become global. But this is to be distinguished from the homogenization involved in the organizational side of the global economy: state-of-the-art office districts, airports, hotels, services and residential complexes for strategic workforces. Architecture and engineering have invented and produced these state-of-the-art environments and provided the key visual vocabularies for the reshaping of significant portions of these cities. This reshaping responds to the needs associated with housing these new economies and the cultures and politics they entail. I would say that this homogenized environment for the most complex and globalized functions is more akin to an infrastructure, even though not in the conventional sense of the term. Nor is it simply a visual code that aims at signalling a high stage of development, as is so often posited in much of the commentary on the matter and is the belief of many developers.

We must go beyond the visual tropes and the homogenizing effect, no matter how distinguished the architecture. The key becomes understanding what inhabits this homogenized state-of-the-art urban landscape that recurs in city after city. We will find far more diversity and distinct specializations across these cities than the newlybuilt urban landscapes suggest. The global economy requires a standardized global infrastructure, with global cities the most complex of these infrastructures. But the actual economic operations, especially on the organizational side, thrive on specialized differentiation. Thus as the global economy expands and includes a growing diversity of national economies, it is largely in the global cities of each of these that the work of capturing the specialized advantage of a national economy gets done. To do this work requires state-of-the-art offi ce districts, infrastructures and all the requirements of luxury living. In that sense then, much of this architectural environment is closer to inhabited infrastructure, inhabited by specialized functions and actors. But these conditions themselves have produced a variety of responses, from renewed passions for aestheticising the city, preserving the city and ensuring the public-space aspect of cities. The massive scale of today's urban systems has brought with it a revaluing of 'terrains vagues' and of modest spaces, where the practices of people can contribute to the making of public space, beyond the monumentalized public spaces of state and crown. Micro-architectural interventions can build complexity into standardized spaces. This type of built complexity can in turn engage the temporary publics that take shape in cities in particular spaces at specifi c times of the day or night.

The city is one moment in often complex processes that are partly electronic, such as electronic markets, or part of hidden infrastructures, such as fi bre optic cables. Embedded software for handling mass systems, such as public transport and public surveillance, is an often-invisible layer in a growing number of cities. Such embedded software is guided by logics that are not necessarily part of the social repertory through which we understand those systems. As the use of embedded software expands to more and more infrastructures for daily life, we will be interacting increasingly with the artefacts of technology. Technical artefacts gradually become actors in the networks through which we move. Buildings today are dense sites for these types of interactions. These acute concentrations of embedded software, and of connectivity infrastructures for digitised space, make the city less penetrable for the ordinary citizen.

Yet at the same time, the city is also potentially the site where all these systems can become visible, a potential further strengthened by the multiple globalities – from economic to cultural to subjective – that localize partly in cities. This in turn brings up political challenges; at various points in history cities have functioned as spaces that politicized society. This is, again, one of those periods. Today's cities constitute the terrain where people from all over the world intersect in ways they do not anywhere else. In these complex cities, diversity can be experienced through the routines of daily life, workplaces, public transport and urban events such as demonstrations or festivals. Furthermore, insofar as powerful global actors are making increasing demands on urban space and thereby displacing less-powerful users, urban space becomes politicized in the process of rebuilding itself. This is politics embedded in the physicality of the city. The emergent global movement for the rights to the city is one emblematic instance of this struggle. In urbanizing rights it makes them concrete: the right to public space, to public transport, to good neighbourhoods.

One question is whether a new type of politics is being shaped through these confl icts; a politics that might also make the variety of inter-city networks into platforms for global governance. Most of today's major social, political and economic challenges are present in cities, often in both their most acute and their most promising forms: the sharpest juxtapositions of the rich and the poor, but also struggles for housing; anti-immigrant politics, but also multiple forms of integration and mixing; the most powerful and globalized economies, but also a proliferation of informal economies; the most powerful real estate developers, but also the largest group of builders in the world today: people making shanty dwellings. How can we not ask whether networks of cities can become platforms for new types of global governance?

**Cities in the world: then and now**

Cities have long been at the intersection of cross-border processes; flows of capital, labour, goods, raw materials, merchants, travellers. Asia and Africa have seen some of the oldest and vastest of these flows, Europe some of the densest. Cities were strategic spaces for the economies and cultures that arose out of these flows and for the housing of power: economic, political and symbolic. The widespread formation of nation-states that took off about a hundred years ago brought with it a move away from these older patterns; the project became one of national territorial integration. From the perspective of this new political economy, cities were mostly routine administrative centres. If anything, the strategic spaces had become the suburbs and the mass manufacturing districts, with the state the critical actor, whether the Keynesian state or the centralized planning state.

It is this last condition, the state as the critical actor, that began to change in the 1980s, accelerated in the 1990s and continues today. Diverse dynamics contributed to the shift: economic, technological, cultural and political. In the economy, it was a result of the privatization of public sector operations, deregulation of the economy, the emergence of new information technologies, the opening of national economies to foreign firms and foreign professionals and the growing participation of national firms and professionals in global markets. States continue to matter and wherever there is war, they play key roles.

While states are still the main global actors, they have lost at least some economic, political and symbolic ground to other actors: global firms and global cities. Global firms have taken over functions and governance capabilities from national states and the 100 richest firms are richer than most except the 20 richest states. The major international flows of people that may have dominated an era (crusaders, armies, colonial functionaries) were once coordinated by states. Today's major international flows of people are more likely to be immigrants, transnational professionals and tourists. In many parts of the world and among many population groups, urban culture is today a far more compelling image than national culture and is becoming increasingly experienced as part of a transnational urbanity. As more and more people live in small towns and suburbs, the large, complex city becomes a tourist destination not just for its museums and monuments, but for its urban surprises, urban dwellers as exotica.

**But why do cities matter for today's global economy?**

Much is known about the wealth and power of today's global firms. Their ascendance in a globalizing world is no longer surprising. And the new information and communication technologies are typically seen as the handmaidens of economic globalization, both as tools and as infrastructure. Less clear is why cities should matter more today in a globalized world than they did in the Keynesian world of the mid-1900s. Today we see a growing number of cities emerging as strategic territories that contribute to articulate a new global political economy. Architecture, urban design and urban planning have each played critical roles in the partial rebuilding of cities as platforms for a rapidly-growing range of globalized activities and flows, from economic to cultural and political.

One way of thinking about the global economy is in terms of the many highly-specialized circuits that constitute it. Different circuits contain different groups of countries and cities. Viewed this way, the global economy becomes concrete and specifi c, with a well-defined geography. Globally traded commodities like gold, butter, coffee, oil or sunfl ower seeds are redistributed to a vast number of destinations, no matter how few the points of origin are in some cases. With globalization, of course, this capacity to redistribute globally has grown sharply. The planet is crisscrossed by these trading circuits. This networked system also feeds unnecessary mobilities, because the intermediary economy of specialized services thrives on mobilities. Thus in the case of the UK economy, a study by the New Economics Foundation and the Open University of London found that in 2004, the UK exported 1,500 tonnes of fresh potatoes to Germany, and imported 1,500 tonnes of the same product from the same country; it also imported 465 tonnes of gingerbread, but exported 460 tonnes of the same product; and it sent 10,200 tonnes of milk and cream to France, yet imported 9,900 tonnes of the same dairy goods from France.

The global map tightens when what is getting traded is not the butter or coffee as such, but rather financial instruments based on those commodities. The map of commodity futures shows us that most financial trading happens in 20 financial futures exchanges, most of which are included in the 16 cities profiled in this Architecture Biennale. These 20 include the usual suspects, New York and London, but in perhaps less familiar roles as well. Thus, New York City, the famous coffee producer, accounts for half of the world's trading in coffee futures. London, not necessarily famous for its mining, is the largest futures trader in the metal palladium. But besides these two major financial centres, these 20 also include Tokyo as the largest trader in platinum, São Paulo as one of the major traders in both coffee and gold, and Shanghai in copper. Finally, some of these centres are highly-specialized in unexpected ways: for example, we have London in control of potatoes. The map tightens even further when we aggregate the 73 commodities thus traded into three major groups. Five major global futures exchanges (NYME, LME, CBOT, TCOM and ICE Futures) located respectively in New York, London, Chicago, Tokyo and Atlanta concentrate 76% of trading in these 73 commodities futures traded globally. Aggregated into three major groups, one single market clearly dominates in each. For agricultural commodities futures, the CBOT (Chicago) controls most global trading; for energy it is the NYME (New York); and for metals, the LME (London).

This escalation in the capacity to control points to the multiple global economic spaces that are being generated. Thus the commodities themselves come from well over 80 countries and are sold in all countries of the world, although only about 20 financial exchanges control the global commodities futures trading. This tighter map of commodities futures trading begins to show us something about the role of cities in today's globalizing and increasingly electronic economy.

It is here that global cities enter the picture. They are not the places where commodities are produced, but they are the places where commodity futures are invented so as to facilitate the global trading of these commodities and partly manage some of the associated risks. They are the places where these futures are traded. It brings to the fore the distinction between the sites and networks for producing the actual good and the sites and networks for managing and co-ordinating the trading of the actual good and the financial instruments they support. It makes concrete what is one of the main counterintuitive trends we see in today's global economy: that the more globalized and non-material the activity, the more concentrated the global map of those activities. This is a puzzle, especially since location in major cities brings added costs to the operations of firms and exchanges. Cities contain the clues to the answer. But before developing that answer, an examination of other such global maps, beyond commodities and commodities futures. An examination of the global networks of global service firms, migration flows and flight patterns shows us a far more distributed global map.

**The global connectivity of Biennale cities**

Here we examine the same types of questions, but with a focus on the top 100 specialized corporate services firms in law, advertising, management consulting, accounting and insurance. These firms operate in 315 cities worldwide, each firm with offices (either headquarters or branches) in at least 15 countries. Each of the sixteen cities profiled in the international exhibition of the 10th Venice Architecture Biennale has some of these offices. These global firms produce and deliver critical inputs for firms, markets and even governments around the world. They service the types of firms involved in the commodity trading and futures markets and the financial services firms described later. And they service architectural and engineering firms, major international art exhibitions, Biennales and avant-garde circuses. In brief, they are in the business of specialized servicing and ready to service the latest inventions not only in the world of firms, but in any world.

Mapping their global operations shows almost the opposite of the sharp concentration of the financial futures exchanges. The servicing operations of these firms are in demand everywhere. When countries open up to foreign firms and investors and allow their markets to become integrated into global markets, it is often foreign service firms that take over the most specialized servicing. This is, clearly, one particular mapping of interconnectivities among a group of very diverse cities. What follows is confined to the inter-city connections among 24 selected cities, including our 16 Biennale cities, rather than the 315 cities in the original data-set generated by Peter Taylor and his colleagues at the GaWC project, who have generously put the data in the public domain. What the numbers capture is the extent to which these 24 cities are connected through the offi ce networks of these 100 firms. This information is one microcosm of a pattern that repeats itself over and over with a variety of other types of transactions, such as the almost meaningless measure of a city with McDonald's outlets or the extreme concentration of the commodities futures discussed earlier. Against this background, the connectivity measures of such office networks are a middle ground, very much a part of the infrastructure for the new inter-city geographies.

Except for Turin and Lagos, all the cities in our sample are in the top third of the 315 cities where these firms either have headquarters or branches. Five of our 24 cities are among the top ten of the worldwide total for the 315 cities where these firms have operations. Londonand New York stand out in our sample, as they do in the world generally, with vastly higher levels of connectivity than any other city. A second, rather diverse grouping for the 24 cities includes Tokyo, Milan, Los Angeles and São Paulo. A third grouping includes Mexico City, Jakarta, Buenos Aires, Mumbai, Shanghai and Seoul; a fourth grouping Moscow, Johannesburg, Istanbul, Manila and Barcelona; and a fifth group Caracas, Bogotá, Berlin, Dubai and Cairo. Turin and Lagos are at a considerably lower level of connectivity. Yet we should clarify that Turin, with the lowest connectivity of our selected cities, nonetheless houses offices of 14 of these global firms, pointing to the extent to which these firms network the world, albeit on their specialized and partial terms.

Some of these outcomes refl ect key patterns in the remaking of space economies. Thus Berlin and Turin rank low because the major international financial and business centres in their respective countries, Frankfurt and Milan, are extremely powerful in the global network and concentrate a growing share of the global components in their national economies. This is a pattern that recurs in all countries; I return to it in the next section. In banking and finance, Jakarta's connectivity is high because it is a major and long established banking centre for the Muslim world in Indonesia's geopolitical region and hence is of great interest to Western firms but is also in need of these firms to bridge into the West. Shanghai's connectivity is high because it is one of the major financial centres for its region and has become the leading national stock market in China – with Hong Kong having regained its position as China's leading international financial centre. South Korea is the tenth largest economy in the world and has undergone significant deregulation after the 1997 Asian financial crisis. It has made Seoul an attractive site for Western financial firms as foreign investors have been buying up a range of holdings in both South Korea and Thailand since the 1997 financial crisis. Dubai is an interesting case that points to the making of a whole new region, one not centred in the operational map of our top 100 global service firms. Only in the last few years has Dubai become an important financial and business centre at the heart of a new emergent region that stretches from the Middle East to the Indian Ocean; its financial global connectivity is not principally derived from Western financial fims but increasingly its own and its region's firms. Its specific financial connectivity is not picked up when we focus on the interactions among the 24 cities, but its accounting connectivity is extremely high for the very simple reason that Western style accounting rules the world.

When we disaggregate these global connectivity measures by specialized sectors, there is considerable reshuffl ing because of the high level of specialization that marks the global economy. In accountancy, Mexico City and perhaps most dramatically, Dubai and Cairo, move to the top. These cities are becoming deeply connected with global economic circuits, they mediate between the larger global economy and their regions and hence they offer the top global accounting firms plenty of business. In contrast Shanghai moves sharply down; the global accounting firms have set up their operations in Beijing because going through the Chinese government remains critical.

The other sectors evince similar reshufflings. The often sharp changes in the degree of connectivity for different sectors in a given city is generally due to misalignments between global standards for legal and accounting services and the specifi cs of the national systems. Global insurance firms have clearly decided that locating in Johannesburg and Shanghai makes sense, as these move to the top ten among our selected cities. It signals that the domestic insurance sector is either insufficiently developed or is too 'unwestern' to satisfy firms and investors and hence foreign insurance firms can gain a strong foothold. The low connectivity of Seoul and Mumbai tells us that the domestic insurance sector is taking care of business. The high connectivity for legal services in the case of Moscow, São Paulo and Shanghai, which all move into the top 10, signals the need for Western style legal services in a context of growing numbers of foreign investors and firms. São Paulo, for instance, hosts about 70 financial services firms from Japan alone. In management and consultancy, Buenos Aires, São Paulo, Seoul and Jakarta move into the top ten of the 24 cities, in good part due to the dynamic opening up of their national economies in the 1990s and the resulting opportunities for foreign and national firms and investors. Barcelona, Mumbai and Cairo have drawn far fewer of our global 100 service firms because either the domestic sector could provide the services, as is the case in Mumbai and Cairo, or the opportunities lie elsewhere, as is suggested by Spain's massive investments throughout Latin America and now even including banking in the UK. For the top 100 global advertising firms, Mumbai and Buenos Aires, both with rich cultural sectors and industries, were a strong draw. Again, the weaker presence of global advertising firms in Cairo and Dubai is due to these cities' sharper orientation to their emergent region. London has the strongest presence of these global firms in accounting, banking/finance and insurance, and New York is strongest in advertising and management consulting. It should be noted that this dominance is due mostly to the sharp concentration of headquarters, as well as branches.

The global map produced by the operations of the top 100 service firms is dramatically different from that produced by the financial trading of commodity futures, which is in turn different from that of the trading in the actual commodities. The extreme concentration evident in finance would stand out even more if we drew a map of goods trading and the innumerable criss-crossing circuits connecting points of origin and destination.

Similarly, the global maps of immigration flows and airplane travellers are also far broader and involve hundreds and hundreds of cities. Many of the selected cities receive immigrants. The highest share is, not unexpectedly, in Dubai, with 82% of its population foreign born, followed by Los Angeles and New York with well over 30%, London just under 30%, to under ten percent in most of our cities and about 1 % in Jakarta, Cairo and Mexico City.

We looked at flights among the group of 24 cities to get a measure of each city's percentage of the total of flights among them. This information was derived from a far larger sample produced by Ben Derudder at the University of Ghent, who kindly has put this in the public domain. To avoid the distortion of hubs, we used the full trip. Not unexpectedly New York, London and Los

Angeles have the largest number of connections within the group of 24 and with the world. NY dominates traffic with Latin America, Los Angeles with Asia and London dominates global routes. Links among these three top hubs are strong. Further, there are strong connections between particular sets of cities: Dubai and Cairo, Mumbai and Johannesburg; Johannesburg and London; Lagos and London, New York and Johannesburg. One of the strongest links is Shanghai and Tokyo and also Shanghai and Taipei. Six of our cities are among the top 20 of the 315 cities as measured by airline passenger traffic. In actual numbers of arrivals and departures, several of the 24 selected cities are among the top of the 150 cities with the largest numbers: London between 30 and 32 million, New York between 28-30 million, Paris 18-20 million, Los Angeles 16-18 million, Milan 8-10 million, Madrid and Tokyo between 6 to 8 million. The numbers for Mexico, Dubai, São Paulo, Berlin, Mumbai, Johannesburg and Seoul, each range from 4 to 6 million. Buenos Aires, Cairo, Istanbul, Shanghai, Jakarta and Moscow handle from 2 to 4 million and the remaining cities below 2 million.

**The most strategic and tightest inter-city geography**

Finance is probably the most extreme case for examining the question as to why the thick places that are cities should matter for global and largely electronic economic sectors. And we know that they do matter. Global finance today moves between electronic space and a network of about 40 very material financial centres worldwide. The question we actually need to ask is why does a global electronic market for the trading of digital instruments need financial centres at all, let alone a network of them? If anything, we might argue that one super financial centre should do. Examining the utility of the network of financial centres provides the most extreme answer to the general question as to why cities matter.

The geography of global finance evinces three major patterns. One is that the number of globally-articulated financial centres began to grow sharply in the 1990s with the deregulation of their respective economies, a trend that continues today but at a slower rate. Mexico City, Buenos Aires, Istanbul, Mumbai, Shanghai and numerous other financial centres joined the global network in the 1990s. Such integration does not mean that all financial centres are located on the same financial circuits. Global finance is made up of multiple specialized circuits, well beyond those briefly discussed for commodity futures. Each of these specialized circuits involves specific groups of cities. Thus although London and New York are the largest financial centres in the world, when we disaggregate global finance into these specialized circuits, several other cities dominate in some of these circuits, notably Chicago in commodity futures trading.

A second major pattern is that notwithstanding the growth in the number of centres and in the overall volume of global finance, there is sharp concentration in the major centres. The commodities futures made this clear already. It is also evident in stock markets.

A third major pattern is the growing concentration of global finance in a single financial centre within each country, even when that country has multiple financial centres. Further, this consolidation of one leading financial centre in each country is due to rapid financial growth and not because the other centres are declining. There are exceptions, but they are rare. In France, Paris today concentrates larger shares of most financial sectors than it did 10 years ago and once important stock markets like Lyon have become 'provincial' even though Lyon is today the hub of a thriving economic region. Milan privatized its exchange in September 1997 and electronically merged Italy's 10 regional markets. Frankfurt now concentrates a larger share of the financial market in Germany than it did in the early 1980s and so does Zurich, which once had Basel and Geneva as significant competitors.

We might think that this concentration inside countries is due to the relatively small size of these countries. But that is not the case. In the U.S. for instance, the aggregate global financial sector in New York dwarfs all other financial centres, including Chicago. The fact that Chicago concentrates far more of the global commodity futures than New York, does not significantly override New York's aggregate financial concentration. The question then becomes why such enormous concentration in one financial centre in this vast country with a multi-polar urban system? Sydney and Toronto have equally gained power in continental-sized countries and have taken over functions and market share from what were once the major commercial centres, respectively Melbourne and Montreal. So have São Paulo and Mumbai, which have gained share and functions from respectively Rio de Janeiro in Brazil and New Delhi and Calcutta in India. These are all huge countries with several major cities; one might have thought that they could sustain several similarly weighty financial centres.

Why is it that at a time of rapid growth in the network of financial centres, in overall volumes and in placeless electronic transactions, we have such sharp trends towards concentration both at the global level and within each country? Both globalization and electronic trading are about expansion and dispersal beyond what had been the confined realm of national economies and floor trading. Geographic dispersal would seem to be a good option given the high cost of operating in major financial centres. Further, the geographic mobility of financial experts and financial services firms has risen sharply. In brief, the weight of major centres inside each country is, in a way nonsensical, especially given multiple cities in each of these countries. But so is, for that matter, the existence of an expanding network of financial centres. Indeed, one might well ask why financial centres matter at all.

**The ongoing weight of centrality and density: the other side of global dispersal**

Cities have historically provided national economies, polities and societies with something we can think of as centrality. The usual urban form for centrality has been density, specifically the dense downtown. The economic functions delivered through urban density in cities have varied across time. But they are always a variety of agglomeration economies, no matter how much their content might vary depending on the sector involved. While the financial sector is quite different from the cultural sector, both benefit from agglomeration, but the content of these benefits can vary sharply. One of the advantages of central urban density is that it has historically helped defray the risk of insufficient variety. It brings with it diverse labour markets, diverse networks of firms and colleagues, concentrations of diverse types of information on the latest developments and diverse marketplaces.

The new information and communication technologies (ICTs) should have neutralized the advantages of centrality and density. No matter where a firm or professional is located, they should have access to many of the needed resources. In fact, the new ICTs have not quite eliminated centrality and density and hence the role of cities as economic and physical entities. Even as much economic activity has dispersed, the centres of a growing number of cities have expanded physically, at times simply spreading and at times in a multi-nodal fashion. The outcome is a new type of space of centrality in these cities: it has physically expanded over the last two decades, a fact we can measure it and it can assume more varied formats, including physical and electronic formats. The geographic terrain for these new centralities is not always simply that of the downtown; it can be metropolitan and regional. In this process, the geographic space in a city or metro area that becomes centralized often grows denser than it was in the 1960s and 1970s. This holds for cities as different as Zurich and Sydney, São Paulo and London, Shanghai and Buenos Aires.

The global trend of expanded newly-built and rebuilt centralized space suggests an ironic turn of events for the impact of ICTs on urban centrality. Clearly, the spatial dispersal of economic activities and workers at the metropolitan, national and global level that began to accelerate in the 1980s represents only half of what is happening. New forms of territorial centralization of toplevel management and control operations have appeared alongside these well-documented spatial dispersals. National and global markets as well as globally-integrated operations require central places where the work of globalization gets done, as shown by the case of financial centres. Centrality remains a key feature of today's global economy. But today there is no longer a simple, straightforward relation between centrality and such geographic entities as the downtown, or the central business district (CBD). In the past and up to quite recently, the centre was synonymous with the downtown or the CBD. Today, partly as a result of the new ICTs, the spatial correlates of the centre can assume several geographic forms, ranging from the CBD to the new global grid comprising the 40 global cities discussed earlier.

There are several logics that explain why cities matter to the most globalized and digitized sectors in a way they did not as recently as the 1970s. Here I briefl y focus on three of these logics.

The first one concerns technology and its many misunderstandings. When the new ICTs began to be widely used in the 1980s, many experts forecast the end of cities as strategic spaces for firms in advanced sectors. But it was the routine sectors that left cities while advanced sectors kept expanding their operations in more and more cities. Today's multinationals have over one million affiliates worldwide. But they also have expanded their central headquarter functions and fed the growth of a separate specialized services sector from which they are increasingly buying what they once produced in-house. Why were those experts so wrong? They overlooked a key factor: when firms and markets use these new technologies they do so with financial or economic objectives in mind, not the objectives of the engineer who designed the technology. As I have explained in detail in some of my other work, the logics of users may well thwart or reduce the full technical capacities of the technology. When fi rms and markets globalize their operations thanks to the new technologies, the intention is not to relinquish control over the worldwide operation or appropriation of the benefi ts of that dispersal. Insofar as central control is part of the globalizing of activities, their central operations expand as they expand their operations globally. The more powerful these new technologies are in allowing centralized control over globally dispersed operations, the more these central operations expand. The result has been expanded office operations in major cities. Thus the more these technologies enable global geographic dispersal of corporate activities, the more they produce density and centrality at the other end; the cities where their headquarter functions get done.

A second logic explaining the ongoing advantages of spatial agglomeration has to do with the complexity and specialization level of central functions. These rise with globalization and with the added speed that the new ICTs allow. As a result global firms and global markets increasingly need to buy the most specialized legal, accounting, consulting and other such services. These service firms get to do some of the most difficult and speculative work. To do this work they benefit from being in complex environments that function as knowledge centres because they contain multiple other specialized firms and high level professionals with worldwide experience. Cities are such environments, with the 40 plus global cities in the world the most signifi cant of these environments, but a growing number of other cities developing one or another element of such environments.

A third logic concerns the meaning of information in an information economy. There are two types of information. One is the datum, which may be complex yet is standard knowledge: the level at which a stock market closes, a privatization of a public utility, the bankruptcy of a bank. But there is a far more diffi cult type of 'information', akin to an interpretation, evaluation or judgment. It entails negotiating a series of data and a series of interpretations of a mix of data in the hope of producing a higher order datum. Access to the fi rst kind of information is now global and immediate from just about any place in the highly developed world and increasingly in the rest of the world thanks to the digital revolution. But it is the second type of information that requires a complicated mixture of elements (the social infrastructure for global connectivity), which gives major financial centres a leading edge. When the more complex forms of information needed to execute major international deals cannot be retrieved from existing databases no matter what one can pay, then one needs the social information loop and the associated de facto interpretations and inferences that come with bouncing off information among talented, informed people. It is the importance of this input that has given a whole new importance to credit rating agencies, for instance. Part of the rating has to do with interpreting and inferring. When this interpretation becomes 'authoritative' it becomes 'information' available to all. The process of turning inferences or interpretations into 'information' takes quite a mix of talents and resources. In brief, the density of central places provides the social connectivity that allows a firm or market to maximize the benefits of its technological connectivity.

**Specialized urban spaces and intercity connectivities: A world apart**

The network of about 40 global cities in the world today provides the organizational architecture for cross-border flows. A key feature of this organizational architecture is that it contains both the capabilities for organizing enormous geographic dispersal and mobility and the capabilities for maintaining centralized control over that dispersal. The management and servicing of much of the global economic system takes place in this growing network of global cities and regions. While this role involves only certain components of urban economies, it has contributed to a repositioning of cities both nationally and globally. The types of activities described above are part of a new type of urban economy that is most pronounced in global cities but also is emerging in smaller and less globalized cities. This new urban services-centred core has mostly replaced the older typically more manufacturing oriented core of service and production activities. In the case of cities that are global business centres, the scale, power and profi t levels of this new core suggest that we are seeing the formation of a new urban economy. Even though these cities have long been centres for business and banking, since the early 1980s there have been dramatic changes in the structure of the business and financial sectors and a sharp ascendance of a cultural sector. The sharp increases in the overall magnitude of these sectors, their weight in the urban economy and the critical mass of highincome professional jobs they generate, all have altered the character of cities. This mix has contributed distinct economic, social and spatial patterns in cities beginning in the late 1980s and early 1990s in much of the highly developed world and in the 1990s and onward in major cities in the rest of the world. The growth of this services core for firms is also evident in cities that are not global. Some of these cities serve regional or sub-national markets; others serve national markets and/or global markets. While regionally- and nationally-oriented firms need not negotiate the complexities of international borders and the regulations of different countries, they are still faced with a regionally-dispersed network of operations that requires centralized control and servicing and the full range of corporate business services: insurance, legal, accounting, advertising and the like. Also in these cities we see an increase in high-income professional jobs and thereby growth in sectors linked to quality of life, including the cultural sector. Thus the specifi c difference that globalization makes in this general trend of growing service intensity in the organization of the economy is to raise the scale and the complexity of transactions and the orders of magnitude of profits and incomes.

The implantation of global processes and markets has had massive consequences for the restructuring of large stretches of urban space. The meanings and roles of architecture and urban design are destabilised in cities marked by digital networks, acceleration, massive infrastructures for connectivity. Older meanings of architecture and urban design do not disappear, they remain crucial. But they cannot always comfortably address these newer meanings and presences in the urban landscape. Particular urban spaces are becoming massive concentrations of new technical capabilities. Particular buildings are the sites for a multiplication of interactive technologies and distributed computing. And particular global communication infrastructures are connecting specifi c sets of buildings worldwide, producing a highlyspecialized interactive geography, with global firms willing to pay a high premium in order to be located within it. AT&T's global business network now connects about 485,000 buildings worldwide. This is a specific inter-city geography that fragments the cities where these buildings are located. The most highly-valued areas of global cities, particularly financial centres, now contain communication infrastructures that can be separated from the rest of the city, allowing continuous upgrading without having to spread it to the rest of the city. And they contain particular technical capabilities, such as frame relays, which most of the rest of the city lacks. This specialized layer of connectivity is perhaps most visible and easiest to appreciate if we take the types of global networks that AT&T (see picture 8, 9), for instance, has set up for multi-national firms. Multiplying this case for thousands of multi-national firms begins to give us an idea of these new inter-city connectivities, largely invisible to the average citizen. Such globally-networked spaces of centrality are in their aggregate a platform for global operations of fi rms and markets. One question this raises, to which I will return in the fi nal section, is whether they can also be used for governance purposes.

The globalized sector has imposed a new valorization dynamic in the urban economy; a new set of criteria for valuing or pricing various economic activities and outcomes. The result is not simply a quantitative transformation. It can have devastating effects on large sectors of the urban economy, even as it contributes enormous dynamism. At different times different cities have been emblematic of this creative destruction: New York, Tokyo and London in the 1980s, Buenos Aires and Mumbai in the 1990s (and Mumbai again today) and Shanghai as we moved into the twenty-first century.

**The Other economy in global cities**

In these cities we also see a rapid proliferation of types of firms and types of economic spaces we think of as backward, as unconnected to the advanced urban economy. This is most visible and controversial in the global cities of highly developed counties. Involved are mostly familiar activities: garment manufacturing, construction, transport, packaging, catering, auto repair and so on. These are all licit activities. But they are taking place outside the regulatory framework in a context where those activities are regulated. We call these informal economies and in a context of state regulation these economies can only be understood in their relation to the formal economy, that is to say, incomegenerating activities that adhere to existing regulations. Such informal economies have long existed in the cities of the less developed world and they include today's vast numbers of shanty dwellers, the largest group of builders in the world. One problem in understanding the meaning of these informal economies in the global cities of the highly developed world is that analysts and policy makers often group informal and illegal activities. Both are simply classifi ed as breaking the law. This obscures the two questions we should really be asking. Why have these licit activities gone informal? These are activities that could be done above ground, unlike illegal activities such as tax evasion or trading in banned drugs. Secondly, why have they gone informal now after a century of successful effort to regulate them in most developed countries and certainly in Europe and in Japan?

Seen in this way, the recent growth of informal economies in major global cities in North America, Western Europe and to a lesser extent, Japan, raises a number of questions about what is and what is not part of today's advanced urban economies. Typically this informality is seen as the result of a failure of government regulation and as an import from the less-developed world by immigrants replicating survival strategies typical of their home countries. Related to this view is the notion that 'backward' sectors of the economy are kept backward or even alive, because of the availability of a large supply of cheap immigrant workers. The notion of government failure and economic backwardness also excludes the possibility of a new type of informal economy emerging in the global cities of the less developed world; the assumption is that nothing has really changed in the longstanding informal economies of the global south.

In my reading of the evidence all of these notions are inadequate; they capture only a small part of this new reality in-the-making. Many of today's informal activities are actually new types of economies linked to key features of advanced capitalism, as I discuss in the next section. This in turn also explains the particularly strong presence of informal economies in global cities. And it contributes to explain a mostly overlooked development: the proliferation of an informal economy of creative professional work in these cities: artists, architects, designers and software developers. Finally, we are seeing similar trends towards the emergence of the new types of informal economy also in major cities in Latin America, Africa and much of Asia.

In brief, the new informal economy in global cities is part of advanced capitalism. One way of putting it, is that the new types of informalization of work are the low cost equivalent of formal deregulation in finance, telecommunications and most other economic sectors in the name of flexibility and innovation. The difference is that while formal deregulation was costly and tax revenue as well as private capital went into paying for it, informalization is low-cost and largely on the backs of the workers and fi rms themselves. In the case of the new, creative professional informal economy, these negative features are mostly absent and informalization greatly expands opportunities and networking potentials. There are strong reasons why these artists and professionals operate at least partly informally. It allows them to function in the interstices of urban and organizational spaces often dominated by large corporate actors and to escape the corporatization of creative work. In this process they contribute a very specific feature of the new urban economy: its innovation and a certain type of frontier spirit. In many ways this represents a reinvention of Jane Jacobs's urban economic creativity.

Rather than assume that Third World immigration is causing informalization in the global cities of the north, we need to examine the role such immigration might or might not play in this process. Immigrants, insofar as they tend to form communities, may be in a favourable position to seize the opportunities represented by informalization. But the opportunities are not necessarily created by immigrants. They may well be a structured outcome of current trends in advanced economies. Again the case of growing informal professional creative economies in cities as varied as Berlin, New York and Buenos Aires, makes this link more transparent given the value put today on the 'creative classes'. But in fact, the immigrant informal economy is just as valuable in many of these cities to the new urban economy.

Similarly, government failure may well be involved, but governments had solved the issue of informal work by the mid-twentieth century. And for decades this was not an issue: Why now? Furthermore, if there is indeed a global infrastructure for running and servicing the global economy then it is also quite possible that the global cities of the south are undergoing a similar transformation, albeit with their own specifi cities. Conditions akin to those in global cities of the north may also be producing a new type of informal economy in global cities of the south, including a professional creative informal economy. Why assume these cities are not developing a new emergent informal economy that responds to the needs of their advanced economic sectors? These new informal economies need to be distinguished from the old ones that continue to operate in the global south and are still more a result of poverty and survival than of the needs of advanced economic sectors.

The same politico-economic restructuring that led to the new urban economy emerging in the late 1980s and onwards, also contributed to the formation of new informal economies. The decline of the manufacturing-dominated industrial complex that characterized most of the twentieth century and the rise of a new, service-dominated economic complex provide the general context within which we need to place informalization if we are to go beyond a mere description of instances of informal work.

**Spatio-economic segmentations in the city**

The ascendance of the specialized services-led economy, particularly the new finance and services complex and, to some extent, the cultural sector, brings with it the elements for a new urban economic regime, because although this sector may account for only a fraction of the economy of a city, it imposes itself on that larger economy. One of the new pressures is towards a type of spatio-economic polarization that goes well beyond the older forms of inequality that have always marked cities.

Critical here is the fact that the leading sectors can produce super-profits for firms and super-incomes for high level workers. The possibility for super-profits in the leading sectors contributes to devalue urban sectors that cannot generate super-profits, no matter how much the city needs their products and services. The growing demand for state-of-the-art office districts and for the spaces of luxury urban living displaces lower-profit firms and lower-income households. The more modest sectors of the middle class often leave the cities, as do firms that do not need to be in the city. Poor people easily become homeless, including signifi cant numbers of women and children. Low-profit firms who need to be in the city struggle for survival, with many either closing down or informalizing part of their production.

High prices and profit levels in the globalized sector and its ancillary activities, such as top-of-the-line restaurants and hotels, have made it increasingly difficult for other sectors to compete for space and investments. Many of these other sectors have experienced considerable downgrading and/or displacement, as, for example, neighbourhood shops tailored to local needs are replaced by upscale boutiques and restaurants catering to new high-income urban elites. The ascendance of expertise in economic organization in turn has contributed to a whole new valuing of specialized services and professional workers. And it has contributed to mark many of the 'other' types of economic activities and workers as unnecessary or irrelevant to an advanced economy. In this mix of conditions lie some of the key sources for informalization of both low-wage and professional creative informal work. The rapid growth of industries with strong concentrations of high and low income jobs has assumed distinct forms in the consumption structure, which in turn has a feedback effect on the organization of work and the types of jobs being created.

The expansion of the high-income work force in conjunction with the emergence of new cultural forms has led to a process of high-income gentrification that rests, in the last analysis, on the availability of a vast supply of low-wage workers. High-income gentrification is labour-intensive, in contrast to the typical middle-class suburb that represents a capital-intensive process tract-housing, road and highway construction, dependence on private automobile or commuter trains, marked reliance on appliances and household equipment of all sorts and large shopping malls with self-service operations. Highincome gentrifi cation replaces much of this capital intensity with workers directly and indirectly. Similarly, high-income residents in cities depend to a much larger extent on hired maintenance staff than the middle-class suburban home with its concentrated input of family labour and machinery.

Behind the specialty food-shops and boutiques that have replaced many large self-service supermarkets and department stores in cities lies a very different organization of work from that prevalent in large, standardized establishments. This difference in the organization of work is evident both in the retail and in the production phase. High-income gentrification generates a demand for goods and services that are frequently not mass-produced or sold through mass outlets. Customized production, small runs, specialty items, fine food dishes are generally produced through labour-intensive methods and sold through small, full-service outlets. Subcontracting part of this production to low-cost operations and also to sweatshops or households is common. The overall outcome for the job supply and the range of firms involved in this production and delivery is rather different from that characterizing the large department stores and supermarkets where standardized production prevails. Mass production and mass distribution outlets facilitate unionising; specialty food shops and designer furniture do not.

Yet another condition driving informalization in this process of high-income gentrification is the rapid increases in the volume of building renovations, alterations and small scale new construction associated with the transformation of many areas of the city from low-income, often dilapidated neighbourhoods into higher-income commercial and residential areas. What in suburban or peripheral areas in cities might involve a massive programme of new construction, can easily be mostly rehabilitation of old structures in central urban areas that are likely to offer the highest returns on older renovated buildings. The volume of work, its small scale, its labour intensity and high skill content, the pressures of time and the short-term nature of each project all are conducive to a heavy incidence of informal work.

The expansion in the low-income population has also contributed to the proliferation of small operations and the move away from large-scale standardized factories and large chain stores for low-price goods. In good part, the consumption needs of the low-income population are met by manufacturing and retail establishments that are small, rely on family labour and often fall below minimum safety and health standards. Cheap, locally produced sweatshop garments, for example, can compete with low-cost imports. A growing range of products and services, from low-cost furniture made in basements to ‘gypsy cabs’ and family day-care, is available to meet the demand of the growing low-income population. The inadequate provision of services and goods by the formal sector also contributes to informal ways of securing these. This inadequacy may consist of excessively high prices, inaccessible or diffi cult-to-reach locations of formal providers, or actual lack of provision. It would seem that this inadequacy of formal provision involves mostly low-income individuals or areas.

The existence of a cluster of informal shops can eventually generate agglomeration economies that induce additional entrepreneurs to move in. This is illustrated by the emergence in just about all global cities of auto-repair districts, vendors’ districts or clusters of both regulated and informal factories in areas not zoned for manufacturing; these areas are emerging as among the few viable locations for such activity given the increased demand for space by high bidders. The far more regulated cities in much of Europe and in Japan have kept these developments to a minimum compared with the USA and the rest of the world. Once a city has a diverse set of informal firms that use a variety of labour supplies, the entry costs for new entrepreneurs are lower and hence they can function as a factor inducing the further expansion of the informal economy.

In any large city, there also tends to be a proliferation of small, low-cost service operations made possible by the massive concentration of people in such cities and the daily inflow of commuters and of tourists. This will tend to create intense inducements to open up such operations as well as intense competition and very marginal returns. Under such conditions the cost of labour is crucial and contributes to the likelihood of a high concentration of low-wage jobs. This tendency is confirmed by a variety of data sets that show that each one percent increase in, for instance, retail jobs results in an 0.8 per cent increase in below-poverty-level jobs in large metropolitan areas of the global north.

Against this larger background we can now ask, what then is the place in an advanced urban economy of firms and sectors that appear to be backwards or lack the advanced technologies and human capital base of the leading industries? Are they superfluous? And what about the types of workers employed by such firms? The available evidence shows several sources for the expansion of informal activities.

**Informality: a mode of incorporation in dualized cities**

The demand for informally produced or distributed goods and services in today's global cities has several sources and characteristics. It can originate in the formal economy either from final consumers or firms. Most of the informal work in the garment, furniture, construction, packaging and electronics industries is of this type. A second source is the demand from within the communities where many, though by no means all of the informal activities take place. Immigrant communities are a leading example and probably account for much of this second type of demand. A very different type of informal economy arises out of the concentration of artists and professionals, perhaps especially urban and new-media linked professionals in the types of cities we are focusing on in the Biennale. There are differences in the types of jobs found in the informal economy. Many of the jobs are unskilled, with no training opportunities, involving repetitive tasks. Another type of job demands skills acquisition. The growth of informalization in the construction and furniture industries can be seen as having brought about a re-skilling of the labour force, rather than the more standardized, often prebuilt housing of suburban areas. Some jobs pay extremely low-wages, others pay average wages and still others pay rather well, especially in the professional creative informal economy. Across this range there seems to be a saving involved for the employers and contractors compared with what would have to be paid in the formal market. Finally, we can identify different types of locations in the spatial organization of the informal economy. Immigrant communities are a key location for informal activities meeting both internal and external demand for goods and services. Gentrifying areas are a second important location; these areas contain a large array of informal activities in renovation, alteration and small-scale new construction. This is also the space for much of the informal creative economy. A third location can be characterized as informal manufacturing and industrial service areas serving a citywide market.

The specifi c set of mediating processes ultimately promoting the new informal economies are a) increased earnings inequality and the associated restructuring of consumption in high income groups and in very low income groups; b) increased inequality in the profit-making capacities of different types of firms; and c) the inability among many of the providers of the goods and services demanded by high-income households and by high profit-making fi rms to continue operating in global cities where leading sectors have sharply bid up the prices of commercial space, labour, auxiliary services and other basic business costs. Informalizing part or all of these operations has turned out to be one of the ways in which they can continue to function in these cities and meet the real and often expanded demand for their goods and services. It is then the combination of growing inequalities in earnings and in the profit-making capabilities of different sectors in the urban economy that has promoted the informalization of a growing array of economic activities. These are integral conditions in the current phase of advanced capitalism as it materializes in major cities dominated by the new advanced services complex typically geared to world markets and characterized by extremely high profit-making capabilities. These are not conditions imported from less-developed countries via immigration. Further, the new emerging creative informal economy is also caught up in these spatio-economic inequalities even as its contents and projects are radically different from those of the manufacturing and service oriented informal economies. Berlin, with its large concentration of artists, designers, new media activists and of newly emptied and unclaimed spaces, probably offers the most dramatic example of the mix of dynamics at work here.

On a more abstract level, three features stand out about informality in today's major cities. One is that informalizing production and distribution activities is a mode of incorporation into the advanced urban economy. Second, informalising creative work is one of the most entrepreneurial aspects of the urban economy; today's example of the much-praised economic creativity that cities make possible. Third, informalization is the lowcost equivalent of what at the top of the system we have called deregulation; but while the deregulation of finance, telecommunications and other major sectors was expensive and highly formalized, in today's informal economies the cost is absorbed by the actors themselves.

In sum, the new urban core incorporates a far larger mix of firms, workers and economic spaces than is usually recognized. Parts of the immigrant communities in the cities of the global north and parts of the shanty towns in those of the global south are also part of the new advanced urban economy. But experiencing them as such is far more difficult. The corporate complex exudes techne, precision, power and is therewith easily experienced as part of the advanced urban economy. Yet it is not alone in marking the specifi city of today's global cities.

**Challenges and potentials**

I would like to conclude this essay with four observations that are charged with challenges and with potentials. It is, after all, this quality of being charged and slightly unruly that marks the urban condition. A fi rst observation concerns a critical feature of the urban condition, both in the past and today: vast scales juxtaposed with interstitial spaces. The cities we focus on and their emerging inter-city geographies are spaces of massive structures, massive markets and massive capabilities. We might wonder what options such urban spaces offer urban designers, planners and architects to express their interests and ideas. The issue here is not so much the few exceptional or lucky designers who gain a global stage in their particular field. My concern is rather a more diffuse urban landscape of opportunities for 'making' in urban spaces dominated by massive structures and powerful actors. It is not design per se that concerns me here, but rather the larger political economy of design in cities that are part of these new global networked geographies. What is this landscape within which design today needs to function? There are, clearly, multiple ways of positing the challenges facing architecture and planning as practice and as theory. Admittedly, in emphasising the crucial place of cities for architecture, I construct a problem that is not only positioned, but also, perhaps inevitably, partial.

One consequence of the patterns described in the first half of this essay is the ascendance, partly objective and perhaps mostly subjective, of process and flow over fixity and place. Growing velocities render a growing range of urban experiences more of flows than of things, notwithstanding the vast amount of thingness around us. One of my concerns in researching globalization and digitization is to recover the fixity and the materiality underlying much of the global and the digital and obscured by prevailing notions that everything is becoming flow. The first half of this essay showed that the globalizing of activities and flows is in good part dependent on a vast network of places, mostly global cities. These sites contain many kinds of fi xed (and mobile) resources. Things and materiality are critical for digitization and globalization; and places matter for global flows.

Even as massive projects proliferate, these cities contain many under-used spaces, often characterized more by memory than current meaning. These spaces are part of the interiority of a city, yet lie outside of its organizing utility-driven logics and spatial frames. They are terrains vagues that allow many residents to connect to the rapidlytransforming cities in which they live and subjectively to bypass the massive infrastructures that have come to dominate more and more spaces in their cities. Jumping at these terrains vagues in order to maximize real estate development would be a mistake from this perspective. Keeping some of this openness might make more sense in terms of factoring future options at a time when utility logics change so quickly and often violently, excess of high-rise office buildings being one of the great examples.

This opens up a salient dilemma about the current urban condition in ways that take it beyond the more transparent notions of high-tech architecture, virtual spaces, simulacra, theme parks. All of the latter matter, but they are fragments of an incomplete puzzle. There is a type of urban condition that dwells between the reality of massive structures and the reality of semi-abandoned places. I think it is central to the experience of the urban and it makes legible transitions and unsettlements of specific spatio-temporal confi gurations.

The work of capturing this elusive quality that cities produce and make legible is not easily executed. Utility logics won't do. I can't help but think that artists are part of the answer; whether ephemeral public performances and installations or more lasting types of public sculpture, whether site-specific/community-based art, or nomadic sculptures that circulate among localities.

And so are architectural practices located in unforthcoming spaces. There is a diversity of such spaces. One instance is that of intersections of multiple transport and communication networks, where the naked eye or the engineer's understanding sees no shape, no possibility of a form, just pure infrastructure and its necessary uses. Another instance is a space that requires the work of detecting possible architectures where there now is merely a formal silence, a non-existence, such as a modest terrain vague, not a grand one that becomes magnificent through the scale of its decay, such as an old unused industrial harbour. In addition to the other forms of work they represent, architecture and urban design can also function as critical artistic practices that allow us to capture something about this elusive urban quality; going far beyond what is represented by notions such as the theme-parking of the urban.

The making and siting of public space is one lens into these types of questions. We are living through a kind of crisis in public space resulting from its growing commercialization, theme-parking and privatization. The grand monumentalized public spaces of the state and the crown, especially in former imperial capitals, dominate our experience of public space. Users do render them public through their practices. But what about the actual making of public space in these complex cities, both through architectural interventions and through users' practices? Public-access space is an enormous resource and we need more of it. But let us not confuse public-access space with public space. The latter requires making, through the practices and the subjectivities of people. Through their practices, users of the space wind up making various types of 'publicness'.

A second observation concerns the political character of these cities. The other side of the large complex city, especially if global, is that it is a sort of new frontier zone where an enormous mix of people converges. Those who lack power, those who are disadvantaged, outsiders or discriminated minorities, can gain presence in such cities, presence vis-à-vis power and presence vis-à-vis each other. This signals, for me, the possibility of a new type of politics centred in new types of political actors. It is not simply a matter of having or not having power. There are new hybrid bases from which to act.

The space of the city is a far more concrete space for politics than that of the nation. It becomes a place where non-formal political actors can be part of the political scene in a way that is much more diffi cult at the national level. National politics needs to run through existing formal systems, whether the electoral political system or the judiciary. Non-formal political actors are rendered invisible in the space of national politics. Cities, in contrast, can accommodate a broad range of political activities; squatting, demonstrations against police brutality, fighting for the rights of immigrants and the homeless, the politics of culture and identity, gay and lesbian politics. Much of this becomes visible on the street. Much of urban politics is concrete, enacted by people rather than dependent on massive media technologies.

The large city of today, especially the global city, emerges as a strategic site for these new types of operations. It is a strategic site for global corporate capital. But it is also one of the sites where the formation of new claims by informal political actors materializes and assumes concrete forms.

A third observation concerns the relationship of these cities to the typical urban topographic representations we continue to use. The types of developments examined in this essay can only partly be captured through traditional topographic representations of cities. This is not a new problem, but it has become more acute under current conditions. Thus while a topographic description can make visible the global moment as it materializes in urban space, such a description obscures the underlying connections between that globalized space and the informal economies examined earlier. The immigrant communities and growing sectors of shanty towns, which are one of the sites for the new informal economies linked to the advanced globalized economy, would typically be represented as marginal to it all. Secondly, topographic descriptions do not capture the multiplication of inter-city geographies that connect specific spaces of cities, such as the networks of financial centres, or the networks of hundreds of affi liates of global firms, or the specialized infrastructures that connect a few thousand buildings worldwide. Nor can such descriptions capture the informal city as a site for transnational immigrant households and enterprises and for new types of networks of artists and new media enterprises.

More and more urban spaces are today partly embedded in global and digital systems. The emblematic case is perhaps the financial centre that is far more articulated with the global financial markets than with the economy of the city or country in which it is located. On a very different scale, but going in the same direction, it will not be long before many urban residents begin to experience the 'local' as a type of microenvironment with global span. This will include poor and even marginal actors. The outcome for urban space is that at least some of what we keep representing and experiencing as something local; a building, an urban place, a household, an activist organization in our neighbourhood is located not only in the concrete places where we can see it, but also on digital networks that span the globe. A growing number of entities located in global cities are becoming connected with other such entities in cities near and far.

What does it mean for a city to contain a proliferation of these globally-oriented yet very localized offi ces, households and organizations? And what is the meaning of context under these conditions? The financial centre in a global city, or the human rights activist's home are not oriented towards what surrounds them, but to a global process. In its most extreme version, the city becomes an amalgamation of multiple fragments located on diverse trans-urban circuits. As cities and urban regions are increasingly traversed by non-local, including global circuits, much of what we experience as the local because locally-sited is not necessarily local in the traditional sense of the term. This produces a specific set of interactions in a city's relation to its urban topography. The new urban spatiality thus produced is partial in a double sense. It accounts for only part of what happens in cities and what cities are about. And it inhabits only part of what we might think of as the space of the city, whether this be understood as a city's administrative boundaries or in the sense of the multiple public imaginaries that may be present in different sectors of a city's people. If we consider urban space as productive, as enabling new confi gurations, then these developments signal multiple possibilities.

This brings me to the fourth and final observation. Could it be that precisely what urban topography misses is a source of a new type of inter-city potential? At a time when growing numbers of people, economic opportunities, social problems and political options concentrate in cities, we need to explore how urban governments can work internationally to further global governance.

Let me make the case that cities – more precisely, international networks of cities – can contribute to the work of global governance for at least two reasons. One of these is the fact that cities concentrate a growing share of just about all key components of our social and political architectures, including key organizational components of the global economy. A second reason is that most key global dynamics run through cities, in some cases merely momentarily and in others in more durable ways. Global corporations still need the massive concentrations of state-of-the-art specialized resources only cities can bring together; and, as we now know, organized global terrorist networks also need various resources that cities offer, including anonymity. Further, these dynamics tend to come together in cities in a way they do not in other types of places. This makes cities enormously concrete sites and in turn, makes many of these global processes concrete and more legible. These conditions can help in the work of global governance. But there is a broader landscape within which to understand this urban potential for contributing to global governance. Cities have historically been the places for many of our best political innovations, among them civic ideals and citizenship. We are living through a time of transitions that calls for political innovation, for developing the domain of politics and citizenship. The formal political system is less and less able to address some of the key issues we face, including the power and globality of major economic actors discussed in this essay. Many of these challenges play out in cities, at least for part of their trajectories. Urban residents and leaderships should be part of the effort to address the governance challenges we face in this new global context. Much of what we think of and call 'global' actually materializes in cities and in the inter-city geographies produced by economic, cultural and political globalization. The multiple specialized circuits that constitute these intercity geographies are de facto venues for inter-city politics. It is not a question of a 'United Nations of cities'. It is, rather, bringing the global down to its concrete urban moment and recognizing the extent to which one city's specifi c challenges might recur in a few or many other cities. These cover an increasingly broad range of economic, cultural and political issues and even types of armed violence we thought only took place in formal battlefi elds. The residents and leaders of cities are used to addressing concrete conditions. The recurrence of particular global conditions in a few or many cities provides a built-in platform for cross-border governing of such global conditions. Most of what cities need to address will remain domestic. But a growing number of global conditions are hitting the ground in cities. It is these that inter-city governance efforts can help address. It does not mean replacing national and supranational governance. It means capturing the specifi c urban conditions increasingly at play in major dynamics of our time.

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# Questions

## Regarding Scholarship and Research in the Design Professions

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# Questions

## Regarding Scholarship and Research in the Design Professions

“There is no such thing as a dumb question” was a favorite expression of both my mother and father, often repeated, this phrase inspired the curiosity that has led me to study design and architecture. As the title of this reflection, it is an appropriate characterization of an address on the subject of research in the design professions.

**Prologue**

For many years as I stepped to the lectern to make remarks my position was rather obvious, many would even comment that It was as though I had stepped from central casting for the role of an architectural educator. Even though I have taken great care to remain active in professional life and my scholarship over the past several years has had much to do with the culture and conduct of practice, my thoughts were received as those of an academic, and particularly an academic administrator really, a kind of view from the sidelines. With my election as the 2009 President of the American Institute of Architects I find that I have now been called to reflect on our profession as never before. I am expected to be fully engaged in the conduct of our profession and even to lead it onto new ground. Perhaps, more than ever I feel the pull of seemingly divergent life paths.

Certainly, I remain an educator and I am prepared to defend the effectiveness of architectural education and yet I see a growing gulf between practice and education. It seems to me it is a kind of cultural gulf. It is a matter of the culture oftions of top level resources in a limited number of places. Indeed, the organizational side of today’s practice that we must consider together. How can we not see scholarship and practice as mutually dependent? How can we even imagine one without the other if we are ever to build the body of knowledge necessary to define and defend our identity as a profession and as design professionals?

I have decided to address this complex topic by considering it from several perspectives. I begin by making observations that together form a bias. I believe it is important to understand this aspect of any statement regarding research in our discipline because it shapes the entire work that follows. As designers we frequently either deny or ignore our bias in the belief that we operate as with the mind of a beginner every time a challenge is presented to us. It just isn’t so. After considering the bias of my remarks I elaborate on what constitutes a mature mixing of strategies that will inspire our work as scholars and practitioners to move toward unexplored ground. To understand this challenge more fully we must explore our relevance to the questions

To connect learning to practice

is to understand that

the way we teach is relevant to the way we understand architecture,

the way we understand architecture is relevant
to how we understand societal values,

and when the values in society change,
than how we understand architecture changes,
and the way we teach architecture changes.

and it is therefore

critical that we become fully open
to the continual questioning of our learning context.

Constantine Spiridonidis, Professor of Architecture University of Thessoloniki, Head, European Network of Schools of Architecture, speaking to the ACSA Administrators Meeting in Minneapolis, October 2007

The Matter of the Culture of Practice

requires that

the way we understand that architectural education is a comprehensive
experience as much exploration as preparation,

yet

societal transformation operating at a historical pace widens the gulf between the
academy and practice,

we must therefore recognize this growing cultural gulf that is emerging between
us because it does reflect how we understand architecture and the
way we teach architectural practice.

and it is therefore

a matter of the culture of practice
shared by the academy and the professional office.

before society. It is the relevance of our work that will establish its importance. It is my intention to respond to questions of relevancy with further questions of the disciplined actions of the design professional and scholar. Next I reflect on the studio model, it cannot be avoided in our oversight of the academic experience, and the question of its relevance to scholarly pursuits and the nature of research in the studio context is critical to our future. It is my intention to bluntly consider the situation most prevalent in the culture of the studio. This leads to the question of where we are and how we might consider design thought as the third domain of inquiry.

**Observations Establishing a Bias**

Scholarship and professional practice today are affected by dramatic societal transformation. The ideologies operating and the resulting governance structures in the world have placed us in an incredible position of confrontation. We cannot ignore this situation as teachers, scholars and practitioners as we attempt to guide students, clients and users into an architecture of this time and place.

We are arbiters and messengers of our culture. Our attention to the related questions of our time will impact the health of scholarship and of our profession. What is before us is the very matter of the culture of practice. It is the shared ground among us. We lie along a disciplinary continuum implying the interdependence of our relationship.

What does it mean to operate in the design domain of knowledge, either as ducators or as practitioners? What constitutes it, how does it relate to the imperatives before society today, and who contributes to it? Several observations seem obvious to me as I consider what we are to do as teachers, scholars and practitioners of our ancient discipline in order to answer these questions.

*Rigor*

We must be disciplined and rigorous in the identification, definition, development and assessment of the knowledge base of architecture and the creative domain. It is upon measured, critically assessed precedent that we can build with the right opinion of Socrates that is essential to the creative act.

*Relevance*

We must be relevant to issues confronting humanity. The affected detachment of the solitary creative individual is a false premise. Our value as a discipline will only be taken seriously as long as we demonstrate value to the greater context of society.

*Clarity*

We must develop our work with clarity rather than the obfuscation frequently associated with a peudo-theoretical discourse. Clarity is the bridge among those who pursue scholarship, those who practice and those for whom the work is undertaken.

*Performance*

We must understand that rigor, relevance and clarity find their ultimate value in accountability. We are defined as a profession by accountability. Whether in terms of health, safety and welfare, or in the predicted performance of a structure, the measure of our credibility is in accountability.

*Erudition*

And if we are to be effective we must also be erudite. Erudition is the ability to communicate so as to affect the attitudes that guide action through the transmission of knowledge. Rigor, relevance, clarity and the accountability within performance form the basis of teaching. With this as the established bias of my remarks, allow me to articulate the challenges before us as scholars and design professionals.

**From Metrics to Mixtures**

*A Focus on Numbers*

Traditionally in a research culture we have placed a great deal of faith in the various rating systems as proof of our effectiveness in the development of buildings. Yet we also know that a common sense approach to design strategies remains the superior foundation for the work of an architect. While metrics are important, it is also important to recognize that strategies to meet an artificial rating system are little more than a tonic for our conscience. It is a feeling that accompanies doing the right thing. It is not my intention to inflame an argument between empiricist and rationalist models, rather I seek to find the balance of these positions that I know exists within a designed artifact. Getting the numbers right is a good beginning for the search, but only a beginning.

*Forcing the Fit*

For example, while it is apparent that considerably more effort has been made to incorporate strategies that respond to energy and sustainability in the building culture, most of the effort has been dedicated to fitting these approaches into conventional aesthetic and planning strategies. There is presently a tendency among the design stars, who are defined by stylistic choices, to respond to energy and sustainability requirements through a predetermined personal language. Similarly new methods of project development founded on the integrated project delivery process are merely a subset of the greater question of of information transfer on our thought processes. Both cases are forms of post rationalization. This is not new thinking. Fitting in serves the purpose of comforting the unease that accompanies the dramatic transformation we are experiencing. However, it also prevents us from achieving our efforts. We need to be honest with ourselves.

*Adapting the Culture*

The opportunities presented by the transformed design strategies involve moving beyond fitting in. It is an opportunity to transform traditional strategies to meet the challenges of the time ahead. Just as we have witnessed new building types evolve to meet the demands of social and economic pressures, so too we can transform our buildings by the demands of environmental requirements. We can live differently, with less, yet with choices just as rich as those dependent on excess. We can adopt new information technologies to inform our decisions, question conventional knowledge and enter into discourse with a world community on new materials, methods and processes. It is necessary that this discourse be founded on proven knowledge.

*Managing Strategic Mixtures*

What must be accomplished is a mixing of strategies. This begins with the most common sense approaches derived from the experience of centuries. Certainly what is done in Copenhagen is essentially different than what we do in North Carolina. The difference in design strategies is a combination of building materials, plan strategies and site orientation and it is also a response to personal life style choices and cultural traditions. New approaches must complement the traditions we have come to value. And, it is dependent on accepting planning strategies that provide for greater density in our communities, a comprehensive transportation plan, and the emergence of new life and work style arrangements. In other words, no single strategy will be enough to address our challenge.

Managing the mixture of strategies demands of us the building of a comprehensive body of knowledge derived from careful case studies including post occupancy evaluation as well as dedicated research on a wide range of subjects. Managing a complex network of interactive strategies demands a commitment to research and scholarship. It is the opportunity to foster partnerships among those who design and build with the academic community. The mixing of strategies is the pattern of nature and it sets us on a path of regeneration and innovation.

It is therefore the responsibility of the research and scholarship community to discern when getting the numbers right on a project coincides with the development of a strategy that allows for a mixing of approaches and the interaction of ideas. Scholarship not only informs the specific decisions undertaken on a project but it provides the framework for the process itself. It is the development of a design for the approach to a project that is an essential aspect of evolving the design process we commonly accept into a truly scholarly paradigm. Scholarship provides the basis for the design of the design process itself. It is the anecdote to the predetermined notions being fed to the profession under the guise of new software, the latest fashions or even reliance on a variety of rating systems for a sampling of the latest concerns.

**The Challenge of Relevancy**

We therefore begin our search for the scholarly underpinning of our profession by heeding the work of great creative spirits over time that have encouraged innovation by defining it as creative thought with a purpose. With this in mind the nature of creative thinking is then intensely focused on the measured and replicable outcomes of innovation. It is these outcomes that provide the precipice for the leaps of understanding that come with analogy. It is a model for the development of a research culture in design. The most effective tool at our disposal to begin these efforts is the case study. This tool is the shred ground among the practitioner and the scholar. It is what

Within a Learning Organization
the Case Study is a fundamental learning tool

because it

conveys the culture of practice,
explores knowledge creation in practice

develops reliable data on which to build understanding,
emphasizes the importance of reflection in action

reveals new approaches / techniques that foster leadership in making,
exposes non hierarchical transdisciplinary relationships in a web

encourages the evolution of new roles in practice,

that

anticipates needs and aspirations,
encourages reasoned risk,
and inspires individuals to assume leadership,

by conceiving practice as a fundamental education experience.

The Challenge of Relevancy

Is to understand that there are three imperatives we must address

the public health imperative and environmental well-being,
The Centers for Disease Control, Atlanta
The World Health Organization
The US Department of health and Human Services
Healthy People 2010
The Joint Center for Political and Economic Health Studies Institute

the human capital investment,
The Learning Culture
Diversity in Opposition to Isolationism
Best Practices

the socialization of information,
Integrated Project Development
Networks of Relationships
Productive Interaction of Technology

and it is therefore

critical that we become fully open
to the issues before society.

transforms the architectural practice from that of the provision of services to a learning organization. It is the tool that prepares us to address issues of great relevancy with effective and proven strategies.

What are the most pressing issues of our time? We certainly can cite sustainability, Diversity and integrated project delivery as among the most important issues facing our profession today. These are in fact the three most significant initiatives of the American Institute of Architects today. However, challenge of relevancy must be considered in the larger terms of which each of these are a subset. They are public health implied by environmental well-being, by the preparation of individuals who are ready to address the need for new knowledge and by the ever-refining technologies available to us

*The Public Health Imperative*

As architects and builders we are confronted by an environmental challenge that is only superficially an energy efficiency question. It is a public health and welfare issue. We are being held to higher standards of service. Public covenants will demand of us a greater level of accountability and our clients will expect more rigorous performance outcomes. Little of this case is being made by members of our own profession, on the other hand, others have. The Centers for Disease Control in Atlanta and the World Health Organization have openly declared that the built environment has much to do with human health. And the U.S. Department of Health and Human Services in a report titled Healthy People 2010 asserts that the built environment has a significant role to play in the attainment of people’s health and happiness. The Joint Center for Political and Economic Studies Health Policy Institute has followed these statements with demonstrable research linking the health of minority populations with their physical environment. Where have we been?

*Environmental Well-Being*

The urgency to understand that we must address the public health imperative only further reminds us that we are past the time of easy environmental compromises. We have pushed the incredibly resilient environmental systems of our planet to a place where it has begun the process of rejecting the harmful element, us. Our best dreams and fairy tales evolved in a verdant landscape by individuals who lived in close harmony with the land. It was a time when individuals knew firsthand the toil connected to food choices and building construction. It was a time when more land was just across the horizon. Now, these models, no matter how romantic, must be reconsidered. There are just too many of us to spread across the land as we have. We are paving over watershed and aquifer recharge areas. We are developing prime farmland without regard for food and water needs. It is time for new ways and means or they will be forced upon us.

What are the specific lessons for us in these studies? What resources can we draw upon? What specific research can we cite to enable our work and give our decisions credibility? Who will step forward to provide such resources? One thought is very clear. We cannot allow others to build this knowledge base without the participation of our discipline and related profession. If we do, if we do, we surrender our discipline and profession to others. We have been referred to as the "ultimate health care professionals." How do we sustain and even enhance this opinion of our importance? How do we prove it?

*The Human Capital Investment*

Never before have we seen practice defined as such an intricate network of interactions crossing disciplinary and international borders with such ease. The demand for a transformation of design practice is driven by powerful forces that include rapidly evolving building types and almost unimaginable changes in materials and methods of construction. Information technology changes propel the socialization of information responding to client organization and economic models that emerge almost daily to undermine any thoughts of traditional stability. In this context design practice, no matter which specific discipline, must be organized as a learning rather than service culture. In this frame of mind it is the learning culture of the practice that is its most valuable strategic position and the library of experience is its most valuable asset not as treasury of how to, but as a base upon which to grow from. In this culture every member of the team is both teacher and learner.

Practice has become a center of collective intelligence evolving networks of individuals forming new relationships. The time has come when models of scholarship and the scholarly community serve as models for practice. We require new ways in the academy as well as in practice to recognize this emerging culture. No one is immune.

The design office is a place of people, its most important capital investment, enhanced by diversity and a willingness to venture. We cannot expect to make any progress on these issues without confronting directly the fundamental changes expected of us to responsibly see to the future of the design professions. Who learns from whom, and when, is no longer confined to traditional teacher-student relationships. The investment in the evolution of the design practice as a learning organization is no longer optional. It is an imperative that is reshaping the concepts of practice from the office of a single practitioner to the world-wide corporate enterprise. A six-year study of Toyota, reported on in the June 2008 Harvard Business Review, reveals a company that is stable and paranoid, systematic and experimental, formal and frank revealing the ability to embrace contradictions. At the core of this complex behavior is a way of seeing employees not just as a pair of hands, but as knowledge workers. It is the wisdom of experience that is reported on as the company's front lines. It is a culture of core values that is remarkably tolerant of failure and therefore innovative in its result.

If we understand the design office as a learning organization than it is also a place of knowledge development and each office evolves a knowledge culture. What opportunities lie here for the scholar and scholarship?

If a learning culture begins with the individual are we preparing and empowering individuals to provide the leadership to address the looming challenges? Have we considered the specific skills that will be necessary for the design and construction leaders of the future? Is there a priority on the development of a diverse set of voices able to mix environmental and cultural priorities effectively?
What does the scholarship, research challenge mean for the setting and recognition of credentials? What does this mean to the evolution of the roles for individuals in the design and building industry? Do we understand that unless we become more diverse in how we are constituted as scholars and practitioners our approaches will become narrow and therefore less able to address the complexity of the situation before us?

The American Institute of Architects has begun to address these questions by evolving a curricular framework for continuing education that will now underlie all of its continuing education offerings at national meetings. What opportunities for collaboration exist here for the scholars among us? What curricular exploration here can inspire new forms of education?

The ability to seek out best practices and precedents from every source and interpret this information to the best advantage of a project is no longer the province of a select few. It is an imperative that even the most junior members of an office have the ability to carry out such an exercise. Similarly, in the academy it is no longer the advanced graduate students who follow the rigors of scholarship and research. The ability to seek out information from a diversity of sources must be considered a basic skill to enter the design professions. Ultimately, it is the diversity of culture, race and gender, intellectual perspective and experience that will enrich the creative process.

*The Socialization of Information*

It has been said that we can "hear the sound of geography falling." Just as we are linked by environmental patterns, we are also increasingly global in our means of living and working. New information technologies and growing digital currency among people of all ages present us with significant opportunities. The sharing of information across national boundaries, cultural bias and economic means implies an inclusivity that may be a powerful tool to address environmental concerns. Today we connect practitioners across continents without much concern for the social, cultural and environmental implications. It is observed that every culture has been transformed by a sense of speed of change. It certainly was a reality to those at the crux of the technological transformation underway between the Nineteenth and Twentieth Centuries. Yet nothing compares to the immediacy of what are now experiencing. This new form of communication has promulgated work and lifestyles that are amazingly crosscultural but also encourage behaviors that are just not sustainable. Yet this new technology has also worked to provide forms of relationships hitherto unknown in the evolution of society. We are truly on the verge of a society founded on collective intelligence with repercussions we can only imagine. We are evolving away from traditional organizations to networks enhanced by new forms of communication. The servicing of the new organizations will require new institutions to emerge in place of those that will fade in importance. Survival of existing institutions is entirely dependent on their ability to adjust and evolve.

Social networks of work are combining with the socialization of technology to lower the threshold of involvement of individuals and groups into decision processes. It is inevitable that new organizations will emerge from this process.

Further it is important to recognize that we are moving toward the productive interaction of new forms of technology and software operating strategies removing human interaction from the most rudimentary decision tasks. Not since the textile production revolution, provoked by the introduction of new looms that set us off onto the path of the computer, have we experienced the lack of ability by those in charge to execute the services required as is common practice among us today. It is possible for us to be perfectly comfortable with a sophisticated level of technological adoption and yet be clueless about the nature of this transformation. We can be acolytes and Luddites simultaneously. The interaction of technology will become more sophisticated with time demanding more of the human interactions in order to provide the discipline and framework for interaction and action. Collaboration is therefore defined as much by machine interaction as human interaction. Some would recognize this as a form of the productive autonomy of machines. This will influence decision processes and it therefore cannot be ignored as we evolve our thought processes with the aid of new media. It is our imagination that is needed at this moment to act as the guiding light for such advances. How will it do so? What effect does this new social / technological network have on the challenge before us? How can we use this to best effect on the future prospects for our profession?

**Scholarship and Research as Disciplined Action**

*Where is our profession on the subject of research today?*

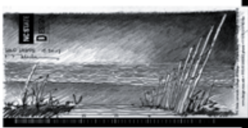
A survey prepared for the American Institute of Architects Academy of Architecture for Health Webinar Research Forum, conducted in Spring 2008 with approximately 400 respondents, indicates a progressive context for research in practice. 86% of respondents have already had clients ask for research based design or for research on a design related topic. 97% of respondents believe that in the future clients will find value in research based design, 59% are currently doing research in the context of their offices but 51% have not yet ventured away from traditional design processes. Approximately 35% of respondents are doing evidence-based design by formulating a hypothesis in advance while 33% use evidence to document outcomes. 33% of respondents have in house formally trained research staff while 71% indicate engaging with consulting experts or academicians to conduct evidence-based project development. 51% indicate repeated difficulty finding useful information in a subject area. As a result 74% indicate that they are either conducting or initiating primary research.

Although the health related constituents of the profession are clearly in advance of the remainder of the profession, we can draw several conclusions from this study. There is a client preference

Architecture

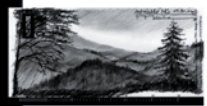
is challenged by the human health and environmental well-being imperative

that will significantly enhance the possibilities of leadership.



Sketch, Marvin J. Malecha


American Airlines Magazine, October 2007

Sketch, Marvin J. Malecha

Advertisement from Good Magazine, September 2007

defining architects as the "ultimate health care professionals".

Dr. Richard Jackson

The professional design office

Is a

living, collective and collaborative evolving organization

Image Source: AD Magazine Cover


Image Source: Architecture Boston Magazine Cover, Nov.-Dec. 2007

The Networked Organization

Diagrams produced following a conversation with Don Lee, FAIA

The Evolving Organization

for evidence-based decision-making. Practitioners believe that clear evidence has a positive impact on design. There is a general lack of reliable, useful evidence. Practice-based methods of research are emerging with and without academic participation. Practitioners will draw expertise on an as needed basis from a variety of sources. External validation is considered essential. This establishes the importance of the research endeavor to the conduct of practice and accentuates the need for those in the academy to think beyond selfabsorptive scholarship into the areas of societal and professional need I have already articulated; human health and environmental well-being, human capital, and the socialization of information.

**Reflecting on the Studio Experience**

I believe the studio is perhaps the most effective learning experience in the academy. Yet our application of it has been narrow. Frankly, in its present form we need to reconsider the notion of it as a center for research. If we wish it to be so, then we must generally apply its pedagogy, accept the central nature of topics as diverse as materials science, structures and the conduct of the profession. We simply cannot continue to value only the abstract, detached and intensely personal notion of what constitutes design scholarship. We must be honest with ourselves, there is too much of a hazy sense of theory wrapping the work found in the format of the studio. This at a time when the profession is seeking hard information in the form of design based knowledge. The effectiveness of the studio experience is most evident in testing and application and given weight by the integrative nature of the exploration. Allow me to repeat myself, if we cannot commit ourselves to the relevancy of our profession to the needs of society and the need to extend ourselves beyond our disciplinary perspective than we need to shake ourselves of the notion that our present conduct of the studio is research, it is not. To those who see it otherwise, if we have been effective in the use of the studio as a center for research than our profession should be awash in a tsunami of new knowledge. We are not. And, these practices have been passed on to the profession. As a profession, we are hampered by a rather myopic view that all must be understood through the eyes of architecture. The perspectives and related decision processes of other disciplines strengthen our ability to understand the world and give us reason to develop our own critical thinking skills.

Rigor, relevance, clarity and performance demand a method that is more inclusive of many forms of inquiry combining to inform the actions of the studio and to place upon it metrics that contribute to knowledge based actions. It is this behavior that will establish design thought as a serious endeavor. Our situation in the world today is urgent and our approach must be multidimensional. There is little room for error if we are to truly address the complexity of the environmental, human capital and information technology issues before us. We can begin to effect change in the manner of how we accomplish our work by tailoring accepted practices to meet new standards, but this is insufficient. The ability to make fundamental, transformational change requires the adoption of a new culture of mixed strategies inspiring new settlement and building patterns. Nature provides the lesson for diversity. It is through a diversity of approaches that we will find a new culture of building and through a diversity of thought that we will discover true scholarship. I think we can agree that what constitutes the majority of the scholarship underway in the academy, and most significantly the studio, must become more structured in its outcomes and transferable to the general use of the profession. How can we formulate such an attitude in our scholarship?

**Where are we?**

I have served as a peer reviewer on a number of proposals, attended many presentations of scholarly efforts and chaired grant selection panels during my career, all too many to count really, leading me to several observations better characterized as friendly advice as to the elements of a strong research/scholarship brief. The foundation of research and scholarship in the design disciplines is derived from the elements that comprise an education in the creative arts. In April of this past year The New York Times Magazine, under the title What can arts education do?, articulated five general outcomes. These include; persistence in addressing problems, observational acuity, expressive clarity, reflective capacity and the ability to envision alternative possibilities. These five characteristics combine to establish a creative process that will effect thought patterns and facilitate the unexpected possibilities that we identify asinspired action.

The standards for research and scholarship must be inspired by these characteristics if the goals of evidence-based design are to be met. Persistence is demonstrated by a trail of scholarship that underpins a proposal. It is experience that provides the authority necessary to articulate the purpose of the research and scholarship. The necessary sweat equity of scholarship elicits respect. There is no substitute for it. Observational acuity is best demonstrated by the ability to see patterns of information. It is from the reading of patterns that curiosity is provoked. Expressive clarity is essential to frame the question to be addressed by the work. Without such authority scholarship can wander and flag, soon diminishing the intensity and purpose of the search. The clarity of the question being asked and the related speculative hypothesis defines the nature of the theory to be proven through the conduct of the study. The root of theory is observed action and therefore reflective capability is an essential capability for a design professional. Reflective capacity not only brings bits of knowledge together to foster a greater meaning for the work, it also sets the framework defining the path of the study and it establishes the methodology and its appropriateness relative to the work being pursued. The structure of research and scholarship is an important aspect of successful inquiry. Project organization establishes the means by which an individual or individuals undertake the study. It establishes the special credentials and experiences brought to the inquiry demonstrating why they are able to undertake the work. The ability to envision the outcomes of scholarship speaks directly to the credentials of the individuals who comprise the team. These credentials must be exhibited as they represent the bias that the scholar or scholars bring to the study. The impact of bias on scholarship and research cannot be underestimated.

With these five characteristics guiding development of a proposal and the conduct of a study, three additional traits are essential to a research proposal. The measures by which the research will be deemed successful articulate the expected outcomes for the work. The replicated per-

The professional design office

Is a

place of people, its most important capital investment.

The Harvard Business Review

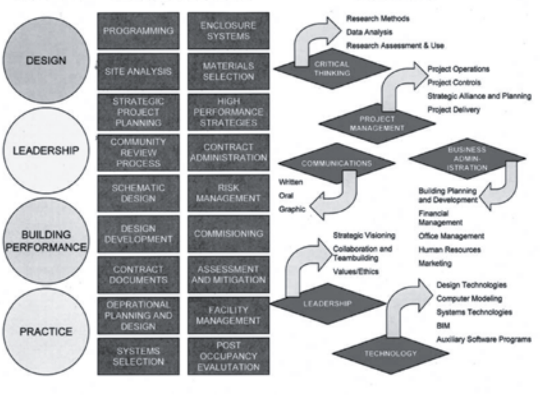
cites the following

A six year study of Toyota, reported in the June 2008 HBR, reveals a company that is stable and paranoid, systematic and experimental, formal and frank revealing the ability to embrace contradictions. At the core of this complex behavior of seeing employees not just as a pair of hands, but as knowledge workers. It is the wisdom experience that is reported on s the company's front lines. It is a culture of core values that is remarkably tolerant of failure and therefore innovative in its result.

and it is therefore

critical that we become understand the question of
human capital as an investment in the future.

In Architecture and Design Practice
learning is defined by a complex set of understandings




From the AIA continuing Education Quality Assurance Panel (CEQUAP) formance of the principles derived from the research, either in practice or in the work of other scholars, is an important verification of the work. Although direct replication is difficult to achieve in the design process the predictability of particular characteristics is not. Finally, the commitment to the dissemination of knowledge is essential to meet the most fundamental mission to build the design domain for all in the study and practice of architecture to use to their advantage.

*Where are we?*

I am a bit worried. Much of what I see is a soft version of the already soft side of humanities. This is at a time when our profession is pleading for knowledge that will advance our discipline and aid practice. Hard knowledge, derived from directly observed performance, not theoretical supposition are often the result of personal curiosity. Where are the scholars and researchers who will dedicate themselves to a purpose larger than themselves? Who will step forward to meet this plea?

**The Nature of Design Thought**

*Design Inquiry as the Third Domain of Knowledge*

We are in a discipline of possibilities. We have finally come to understand that the discipline of design is not a subset of either the sciences or the humanities. Rather, the domain of design knowledge is emerging as a distinct discipline with a history and a manner of thinking and doing that constitutes the third leg of the stool of human accomplishment. This opinion is a deduction reaffirmed by the balance between science and the humanities that is introduced by design thought giving stability to them all. It is a position emerging from design practices demonstrated in studios and progressive design offices. It is a question being fervently pursued as every segment of business and social inquiry is attempting to understand the evolution of creative thought and action. The development of the design domain presents a counterpoint to the study of the humanities dedicated to providing a social and ethical context for the pursuit of knowledge and for those in science and engineering who seek to define our physical world in ever more specific terms. To study design is to consider what does not yet exist. It is an endeavor that anticipates what is to come.

Thomas Edison is the American father of the industry based research studio. The rigor of his approach had a much to do with persistence as with method. His insistence on recording and learning from every move made every step, successful or failed, a valuable aspect of the process. His devotion to the iterative process made his search for needles in haystacks achievable.

There was no failure for Edison, only unexpected learning experiences. He willingly accepted the challenge of rival belief systems to test his own ideas. Are we capable of such thinking? It was through this dogged determination that at points along the way it was possible to mobilize the wisdom of his experience to make leaps of understanding. It is Edison's process that should inspire us as we seek to build a discipline devoted to inquiry.

Consider for a moment the intense sight of Leonardo as he speculated on what must have seemed the spectacular. The design of a device, with a man hanging from its center, to float on air, that we now recognize as a prototype for the common parachute. But from what was he leaping? How do we embrace the courage of thought that is indicated in this one sketch?

Critical design thought, design thinking, has come to the attention of the best minds of business and industry as the means to retain leadership in a world of intense competition. Our disciplines, architecture and the allied design professions, are being sought out as partners and collaborators as never before. The June 2008 issue of the Harvard Business Review is dedicated to this very subject. This is a moment of opportunity for us to assert the importance of our discipline. We will only do so through the nurturing of our knowledge base. Our's is the power to see out onto a new horizon of opportunity.

*A Culture of Collaboration*

Every complex problem demonstrates to us over and over again that the design domain is dependent upon a culture of collaboration. Teams are continually formed and reformed to address the most complex problems. New technologies can be employed to assemble the expertise and perspectives of many ways of seeing. It is from the richness of the resources available to us that solutions will emerge. Clearly, the importance of collective intelligence cannot be under estimated. Organizations are evolving as dynamic social ecologies. Sharing, cycling and continual innovation mimic the open source environment of new technologies. Each organization will undergo a self-evolving process that will develop new combinations, and recombination's, through time and project development. A collective cognition will develop in a fashion that is exhibited in the behavior we witness in the open source environment of wikipedia that enables free sharing, cycling and innovation developing as a social ecology. It is this behavior that will extend our social and work networks into a world-wide culture.

We are reminded that we must address the image of the individual star and the sole creative spirit that continues to dominate the image of the architecture profession. The reality of the profession is that it is entirely dependent on collaboration. Underlying this reality is a sense of disciplined interactions among a diverse team. It is multiplicity that makes networks robust. Multiple perspectives are increasingly critical in an environment of intensive experimentation and communication. Highly specialized expertise is evolving and affecting the outcomes of the creative process.

*A Question of Sight and Clarity*

In this dynamic context we have a looming self identity crisis. As design professionals we are uncomfortable with the concept of a consumer, and we cling to notions of our vocational nature. We are certain of our importance to societal imperatives and our professional standing to lead the response, but increasingly destabilized by emerging expectations. And dramatic change, particularly in the technological arena, has made the profession more and more dependent on the interface between the seasoned and the new practitioner. It is therefore no surprise that in this mix of many questions a greater query remains. How do we arrive at the fundamental awareness of what must be done to either become or remain relevant? Clearly, what is being pursued is a new way of seeing.

We are at a moment when we must use the powers of design thought to find clarity. Today even our architectural expressions have become a cacophony of personal hubris when people are seeking something more from us. We can see and feel the disconnect between architects and society generally. How can we define what more is in a knowledge-based context? I believe in the clarity of design thought and I believe in the power of architecture to inspire. Where does this leave us?

Some years ago a member of the NC State University Board of Trustees placed a child's toy, a simple plastic kaleidoscope, in my hand with the admonition, "it doesn't take a lot of money to see the world differently." The lesson of the kaleidoscope is that we must be prepared to see the world differently. We cannot see this challenge with the same old eyes. Design thought is our most important asset in this endeavor. We are left with that.

*Design Thought as an Ethical Framework*

We are faced with the ethical weight of our choices. The environmental challenge gives us, as design professionals, a grounding between the sunset and the sunrise. We are drawn together with the most ancient traditions of the Anasazi Indians and the cutting edge experiments underway around the world. We must move between thought and making with facility. New technologies are waiting for our use to build collaborative relationships and enhanced information awareness. People and traditions of all economic and social means strengthen our posture and maturity. The choices we make will leave our fingerprints for the judgment of future generations.

In the end, it is those of us who purport to scholarship that are also called to attend to the knowledge base upon which the design disciplines, and particularly the design practitioners, will depend to act in the face of emergent challenges. And, as I have articulated in these few words the challenges are great. Issues related to environmental well-being and human health, the investment in human capital and the transformations in our world culture driven by the socialization of information each present us with opportunities to enhance and enliven our existence or place formidable threats before us that will drive us apart and foul our nests.

Unless we are committed to the most aggressive form of networking, convincing all who can hear of the urgency of our situation and the role of design as a means to address the issues of our time, and actively engaging in the development of a rigorous knowledge base, providing useful information derived from measured performance clearly articulated, it is we who will be called to account.

We are expected to come to this challenge with intensity of purpose, disciplined determination and a sense of optimism as collaborators forming a collective intelligence. What a wonderful time to be a member of the design professions. We are needed. It is we who involve ourselves in the foundations of knowledge from which our beloved discipline evolves. When we address the essential questions before society and our profession it is we who will determine the patterns of action that will define the profession. This is theory and practice determinably different, yet interwoven to fashion a new culture of practice.

Must we as design professionals act only under duress? Must we move between projects only on a need to know basis from which little is learned from one situation to the next? Must we only depend on others for our foundation of knowledge? Obviously not, curiosity, scholarship and the testing that comes with making define us. It is the very essence of who we are. It forms the knowledge base of our profession. It is up to us to reflect in an actionable fashion – to reflect in action in a fashion that is the realizable mix of theory and practice.

**There is joy in what we do. It is time to get on the journey.**

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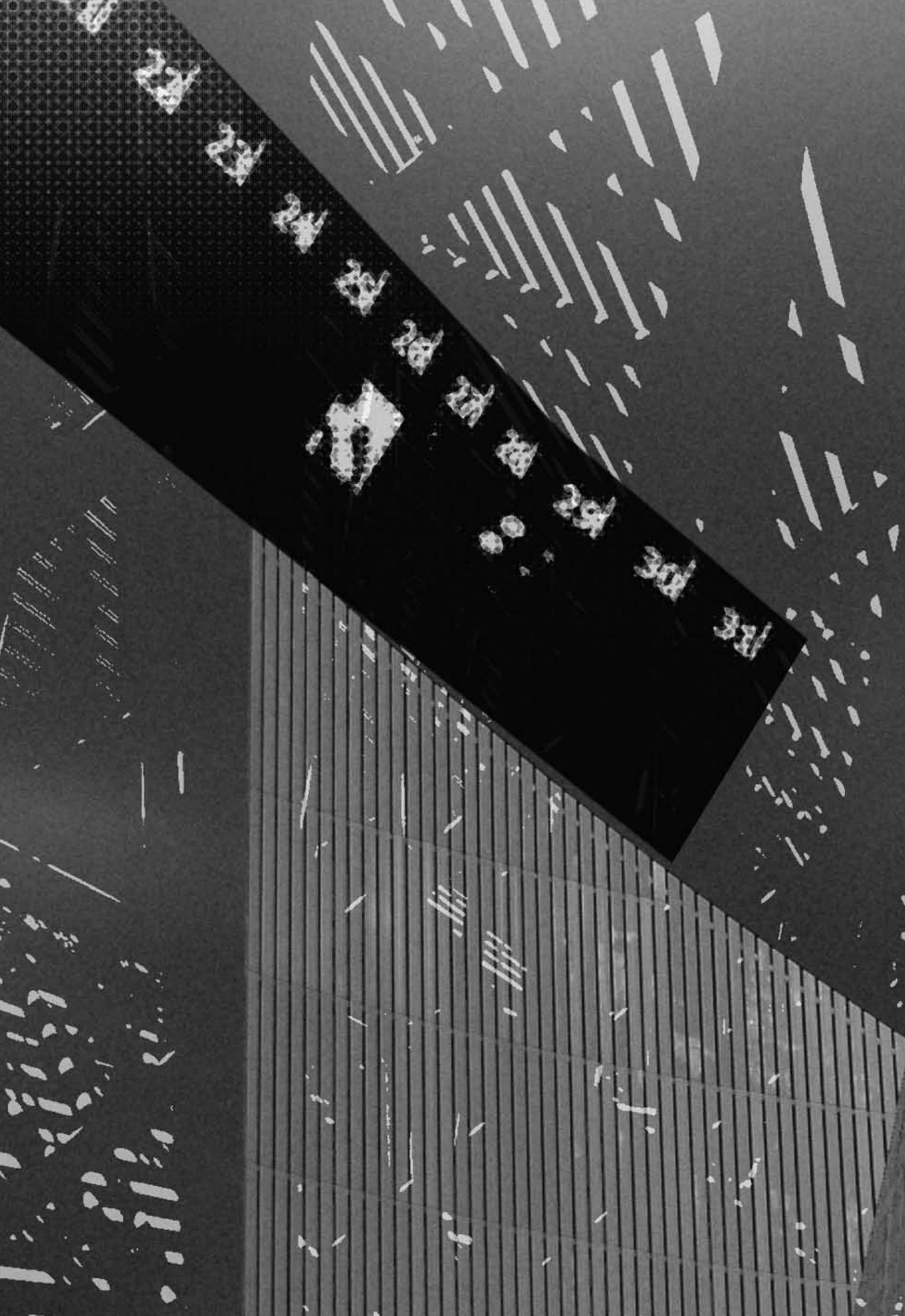

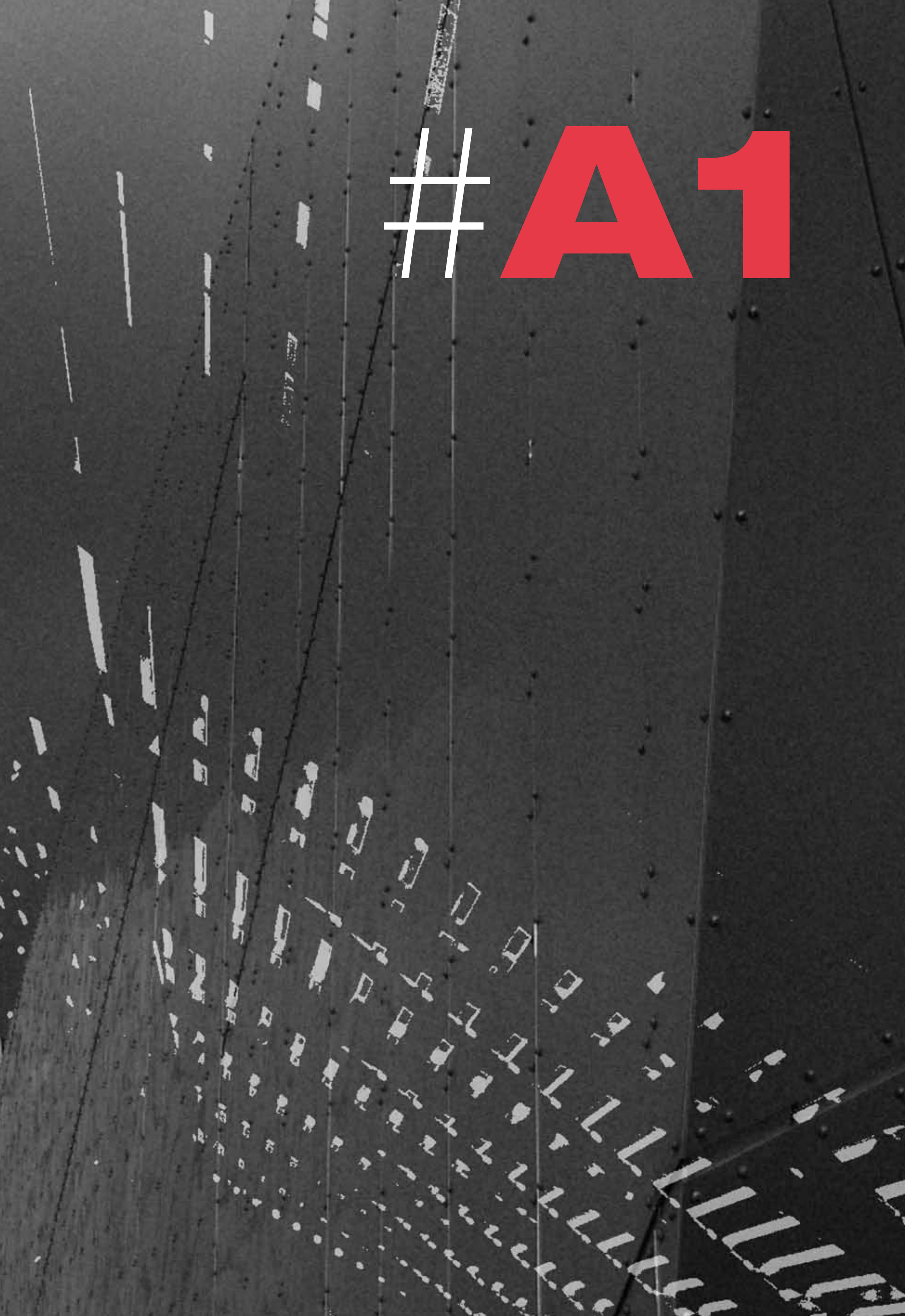
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**Josep Muntanola**

# Architectural design on the treshold of the digital age: Revolution or regression from a dialogical view point

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# Architectural design on the treshold of the digital age: Revolution or regression from a dialogical view point

## 1. Introduction

One thing should be perfectly clear: I am not against the use of the computer in architectural design. On the contrary, I think that each technological advancement is a blessing for architects if, and only if, it is correctly used. Of course, in order to be correctly used, any technological advancement implies new theories and innovative points of view about human development. I think we have these new theories and these innovative points of view, but I also think that architects today are eager to use the computer without any theoretical training. A lot of them consider theories to be obstacles for a free use of the computer, more than a way of improving the design processes. They are wrong, and this is the aim of my brief contribution. Which are these "new theories"? I will present some of them very shortly. The dialogical theory by M. Bakhtin is not strictly new, because it was conceived at the beginning of the twentieth century, but English translations of Bakhtin's book are very recent, and the impact of the dialogical theories is still on its way today. (Muntañola, J. 2007a, 2006) (Camic, C. and Joas, H. eds. 2004) (Ponzio, A. 1998).

Another theory, or better, another "group of theories", related to my proposition are the "bidirectional" theories developed by J. Valsiner (2003), S. Gottlieb (2003), J. Langer (2003), J. Muntañola (2007) and McNamara (1998) that should change our point of view about psychological and social development. Basically, it implies that our physical, social and cultural environment affects our genes, via our behaviour and our neural activity. Moreover, it implies that we can study the "bidirectional" and reciprocal interactions between environment and genes, and we can know the outputs of them.

So we can change our lives and we can know the reasons for these changes. Finally we know now much better the specific cognitive and sensorial qualities of our human "species" in relation to other animals, and we can use much better the heterochronic specific qualities of our mind and body, using the computer, of course. The analysis of the feedback between brain and machine throughout the design process is, in my opinion, the best way to apply these "new theories" that I have just announced here. Our schools of architecture are excellent laboratories for this task, and it is possible to describe how this task is undertaken. One kind of research can help architects in this way: the study on the cognitive use of objects and spaces in a social environment. This kind of research has already a past, however, now the basic cognitive assumptions are totally different and new. Consider for instance the works by Hutchins, E. (2006), or Kirsh, D. (1995), and the PhD thesis by Muntanyola, D. (2008). The dialogical feedback between the brain and the machine can be analysed, then, in the architectural design processes (Muntañola, J. 2008a), and in the use of the buildings (Hillier, B. 1999). In all these approaches I follow the adviser of one of the founders of modern mathematics, the French mathematician H. Pointcaré, who in his PhD thesis about the necessary differences between geometry and the way our body deals with objects states:

*"There are infinite virtual geometries that are all true, we must just use, in the sensible real world, the geometry best suited for our needs in each case".*

(Pointcaré, H. 1898)

**2. The Architect Is in the World of the Digital Age**

Architects find themselves, without planning it, in the centre of the digital age for a lot of reasons. First, because of the impact of new technologies in building, in the use of spaces and in design, three fundamental dimensions of the profession. Second, because of the new mind and body relationships developments, architects are totally submerged inside this discussion, whether or not they want to participate. Third, because the ecological explosion affects architecture and urban planning too. And last, but not least, because the social dimension of cognition impacts architectural design as well as all the sociological theories of today (Muntañola, J. 2008b).

So social sciences, earth sciences and philosophical inquiries are tied together in a very clear fact: architects use computers to design, to build and to forecast social and cultural impacts of buildings and cities. I will try to analyse and to deduce the main problems and answers to this complex digital impact. It is not the first time that architects should confront with changes in design theories and practices. However, this time, the global effect increases ecological, social and mental risks, and opens new chances too. And the speed of these processes is more and more accelerated. Before explaining how we should react to this situation, let us take stand on two theoretical points in order to understand the proposals I want to make in relation to architectural design. These two points are closely related to each other. The first point is fundamental for architects, and deals with the distinction between dialogical versus monological space and time objects: buildings or cities. The second point deals with the distinction between dialogical and Kantian "subjective" transcendental space and time. I will explain these two points immediately, starting with the second one.

Bakhtin, the founder of a dialogical vision of men, rejected the "a priori" philosophical view of E. Kant, about cognitive space and time concepts. Perhaps, disciples of E. Kant misunderstood the Master, but "a priori" space and time concepts have been used as an "original" and "a priori" base for our architectural understanding. Bakhtin states:

*"All words, except my own, are other's words. The immense boundless world of other's words constitutes a primary fact of human consciousness and human life that has not yet been adequately studied".*

(Bakhtin, M. 1986, p. 143) (Written in 1973)

For Bakhtin, then, intersubjectivity precedes subjectivity in relation to phenomenological space and time understanding.

**Figure 1**
**Monological cities** built without any dialogue between children, sexes, age-range, public and private spaces, etc.

**Figure 2**
**Dialogical cities** with socio-physical dialogue between boys and girls, theatre and architecture, age-ranges, private and public, etc.

In my studies with children, during thirty years (Muntañola, J. 1973, 1996, 2007a), I found that this theoretical stand by Bakhtin is profoundly true: children and men cannot isolate mental architectural space and time constructions from social interactions. On the contrary, it is the retroactive dynamic interrelation between objects and subjects that produces our "knowledge" and "ability" to conceive, build and use cities, and, in agreement with Husserl's view on the origin of geometrical concepts, social and physical mental development are two faces of the same coin (Husserl, E. 1962). Of course, Bakhtin is not talking only about scientific space and time, but about the aesthetic and ethic spatial and temporal human qualities too. Another way of analysing this fact is following the French philosopher Paul Ricoeur (Ricoeur, P. 2003), when he insists that it is useless to discuss if building precedes dwelling (social use) or dwelling precedes building. So they have always coexisted together in architectural design and they will always coexist. If this is not the case, simply, then, architectural design will disappear.

This original and fundamental theoretical fact in design, leads us towards the other theoretical point I announced above, illustrated in figures 1 and 2, where the differences between a dialogical and a monological architecture are described. These differences in children's conceptions of architecture can be extended to our present adult situation. And in spite that complexity increases and the relationships between inner and outer body facts are more and more complicated in adults today, the basic dialogical law remains.

**3. How the Technological and Digital Age Affects Architecture**

It is important to consider the digital age as the end of the huge global technological revolution and as the beginning of a new more "humanistic" era. I agree, at this point, to the position of my master Lewis Mumford, for years my advisor in these topics. He wrote to me in 1981:

*"What I was writing fifty years ago has, in recent years, found the audience I have been working for among the new generation here in America and in other communities too. That gives me great satisfaction".*

So, he was, both, pessimistic, faced with the aggressiveness of urban planning destruction, and optimistic about this new sensibility to life in general. It is then the confusion between technology and digital achievements that is now destroying a good use of the computer. Because the first impression of the impact of all that in architecture is a big surprise: Why, in architecture, have cultural development and scientific success been totally different than in medicine, industrial telematics etc.?

In our school the first impact of the computer was a decrease in the quality of design. Students did not have, neither a "manual" quality nor a "digital" mastering. Now things are better, perhaps they do not have a great "manual" artistic gift, but they improve a lot with the machine. Once more, the machine has no responsibility for bad architecture. Both in architecture and in urban planning the machine increases chances to design in one or other direction. It opens chances and innovative variations, but it cannot substitute our brains (Muntañola, J. 2000a).

Here the position of F.Ll. Wright (Pollack, M. 1997) was broadly more clever those of other architects in regards to the machine. He wrote that the machine should be used by the hands and the brains of the best traditional draftsmen. He was deeply right. So we are then confronted with the mind and body discussion that produces hundreds of books each year. I cannot argue about the totality of the complex situation today, with strong scientific battles (Muntañola, J. 2007a). However, it is necessary to explain the kernel of the matter in relation to architecture. We have three different interactions closely tied: the mind and body interaction (design), the building and social use interaction (specially in planning), and the "technical" to "natural" qualities of architecture or the "phenomenological" richness of buildings and cities (only visual or not, etc.). These three different "dialogies" respond to the three deep qualities of architecture itself (diagram I), and opens an extraordinary cultural realm for the architecture of the digital age. We should now enter inside this new realm.

However, a brief analysis of diagram I can help us on the way. In fact, the three dialogies should be understood together because the fundamental point is that, neither the mind-body relationships, nor the physical form-social behaviour, nor the natural versus technological relationships, are "cause-effect" relationships, but physico-cultural interactions, where the mind, the physical entities (objects) and society (social interactions) are always interrelated. Nobody would state that the mind can survive without a body, or social behaviour without physical places, or technological development without natural precedents, but we should think about the specific architectural qualities of these retroactive relationships.

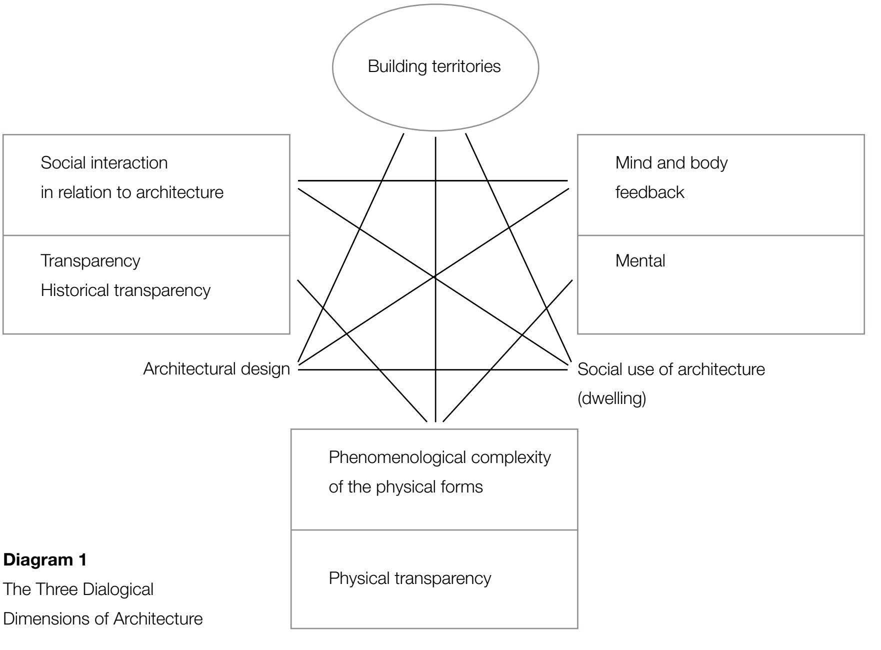


**Diagram 1**
The Three Dialogical
Dimensions of Architecture

#### 4. The New Digital Age for a Dialogical Architect: Notes About Good Practices

Architects who follow this dialogical stand that I have just described have in the computer an excellent machine to help them to succeed. A machine is able to improve the three dialogical interactions described in diagram 1, if, and only if, we use it correctly. This right way can be defined by the following rules:

1) The computer is very good to represent new objects, but it is very bad to represent the "context" of these invented objects. Historical superpositions of archaeological layers, ecological and geographical data from the beginnings of the human era, information about social use and meanings of places, etc. can be analysed and reproduced by our computers, but they are not usually included in our computerized objects (buildings or cities). On the contrary, our brains work always in historical, affective, and cultural contexts. In order to link properly the scientific, aesthetic and ethical dimensions of architectural design this relationship between "texts and contexts" is crucial, both at mental, social and technological levels, as diagram 1 shows.
2) Architectural design is a bridge between reality and virtuality. It is a threshold between past and future, and a basic dimension of human life. However, the digital age, mirroring the economic financial virtual world of development (where, in theory, everybody can be rich, even though we all know this is not the case in reality) substitutes the historical and natural real world by a "virtual" net of virtual objects and virtual subjects. This simulation (an example is the work by M. Novak in the California multimedia lab in Santa Cruz) in spite of the experimental value and televisible media power, is "virtual", and we should not forget that the behaviour of virtual reality is not the same as "real" reality. Science fiction is not scientific, and in its fiction remains its interest. Architecture is not only architectural fiction, and eventhough our imagination can take scientific ideas from artistic representations, to confound both dimensions, art and science, is schizophrenic and socially dangerous. In fact, both, science and art, disappear when we want to identify them.
   In a similar way, I can represent Napoleon, but this artistic rightful commitment destroys itself if I "really" believe I am Napoleon. So the correct use of the computer in architectural design should develop a "critical distance" between the network of relationships between objects and subjects in the project, that is virtual, and the real network in the building, cities and landscapes. Computers do not have "spontaneously" the power of this "critical distance" between virtuality and reality in architectural design, they cannot be "conscious" of the work they are doing. But our brains can play the two (or more) roles in a polychronic and heterochronic way. The brain of the artist, the politician, and the scientist is the same. Architects can play different roles if they understood the basic role of design as an interface between previous reality and future objects and subjects interactions.
3) So, another important role of computers is to overcome the phenomenological "reduction" of environments that are more and more global and less and less local, when an international network of relationships between objects and subjects claims to be the unique and the "true" one. Of course, this is related to the monological versus dialogical challenge in

education stated in figure 1 and figure 2 above, but there is much more here. Three authors are relevant at this point. First, J. Pallasmaa and his phenomenological battle against only "visual" architecture versus an architecture apprehended by all five senses, as it is the case in more traditional, local, environments, but also in some modern avant-garde experiments (Pallasmaa, J. 2005 ). Second, Bill Hillier (1999) and his outstanding work to "measure" the sociophysical interactions between objects and subjects in architecture, with the help of the computer. And, finally, Albert Magnaghi (2000) and his "selfsustainable" urban planning, where the local becomes global, and the global and short term investments, are totally dependent upon the previous social evaluation of the cultural and historical values, in a long term, of the local land and local networks between geography and history that "identify" each place to live.

In the three cases, the computer is necessary to undertake what a lot of architects do not undertake throughout their design. In fact, a lot of architects use the computer to design poor phenomenological objects (according to Jurgen Pallasmaa and followers) objects indifferent to social pathologies and desurbanization processes (according to Bill Hillier) and objects that are conceived in a "global financial" world indifferent to the ecological, social and cultural values that identify the place where they should be build (according to Albert Magnaghi). So computers are not, again, the origin of bad design, on the contrary, they can improve our ability to solve very complex architectural problems, if, and only if, our brains use them correctly.

4) These three conditions are necessary in order to develop a dialogical feedback between the brain and the machine. The quality of architecture depends upon this possibility. Architects have a strong ethical and political role here too. Of course, one architect cannot change the real world, but a lot of architects can help each other to change architecture and to show the way the digital era can accomplish the promises of a better architecture for all. In the last book by Paul Ricoeur, published three months after his death, *Les parcours de la reconnaissance* (Ricoeur, P. 2004), he states the conditions of these promises when he indicates the significance of the "between" (the interface): between myself and the other, between real and ideal, between virtual and real, between past and future, between natural and technical, between private and public, and between cultures. The digital era can build this "between" in order to accomplish some promises in a dialogical world. However, this achievement demands a network of dialogical relationships "between" the mind and the body, the physical and the social values of architecture (so between individual and social development) and, finally, between the natural and the technical dimensions of our territory (see diagram I).

### 5. Can the Dialogical Relationships Between Mind, Land and Society be Improved by the Computer?

I would like to conclude with a statement of hope for the quality of architectural design, for better new urban planning policies and for the peaceful use of the land by social groups. This will not be an easy job. We should be friends of the computer, digital tools and networks, in the sense pointed out in chapter three above. Just some references.

**Figure 3-4**

Dialogical waterfront in empuries (Catalonia, Spain)
This waterfront in the old Greek city of Empuries in Catalonia, Spain, is an example of a touristic resort able to articulate the old city with the new touristic developments without the destruction of a beautiful “natural” site. This is not the usual way of urbanization on the Catalan coast, this is more an exception.
(Made by interdisciplinary teams. Design of the wooden path by Josep Muntañola, Magda Saura Architects.
Getty Foundation Grant for the design coordinated by Professor Magda Saura Carulla, Ph.D UCB, USA).

A first reference that has little to do with the digital age (figures 3-4) is a touristic development in Catalonia, in one of the last pieces of land that is still public land because of the old Greek city ruins of Empuries, and because of its ecological value. It is a success in terms of quality and social use, and accomplishes a piece of the Catalan dream of a coast, used by all in a digital age, without the total destruction of natural systems and cultural precedents. The project was undertaken by an interdisciplinary team in the Technical University of Catalonia and had a grant from the Getty Foundation in California, coordinated by Professor Magda Saura Carulla, architect and historian from the same university.

The next references are taken from final projects in the School of Architecture of Barcelona where the digital tools play a key role by following the conditions of “good practices” explained here. There are dialogical references (figures 5 to 9) and a monological reference (figure 10).

I would like to end my contribution with a short consideration on the brain to mind feedback in the dialogical design, origin of the imaginative processes. Each digital program or “tool” has its

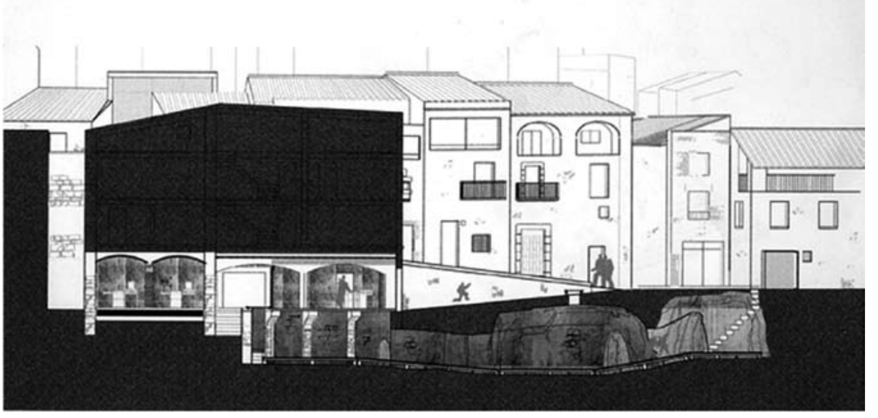

**Figure 5-9**
EXAMPLES OF ARCHITECTURAL
DIALOGICAL DESIGN
Different dialogical ways of using the computer in architectural design in the Final Project at the School of Architecture in Barcelona (according to diagram I).

**Figure 5**
Careful intervention in a medieval village, by taking care of the forgotten old medieval spaces of the underground, and using contemporary architectural means of construction and representation.

own capabilities for a feedback with the brain. There are a lot of them, so it is crucial to know how each program interplays with the brain in a specific and different way. We cannot ask students and architects to do this research by themselves. The "dialogical power" of a program depends upon the conceptual and mathematical bases of it, and upon how these bases affect the dialogical mind-machine interaction (Hutchins, E. 2006). This is almost never thought of in our schools.

Just an example: we know that the digitalization of any curve regardless of its mathematical complexity can be done by the computer with programs on "spline lines". These programs are based upon the algorithm developed by Castleton in 1953. He used the geometrical and mathematical law of tangency known a lot of years ago but not in the same mathematical formulation. However, the interesting point here is that  said he was pushed to this innovation when he observed the way wooden boats were built (and violins) by curving wooden pieces inside a scaffolding that precedes the final form thanks to the tangencies. As architects build a lot of wooden models by bending the material, this is a good way to increase our imagination. This "conceptual" training can also be done in relation to the "memory"  of the programs in contrast with the "memory" of our brains etc. Then a list of programs should be tested in relation to the brain-machine feedback, that is, about the dialogical "power" of each program or tool.

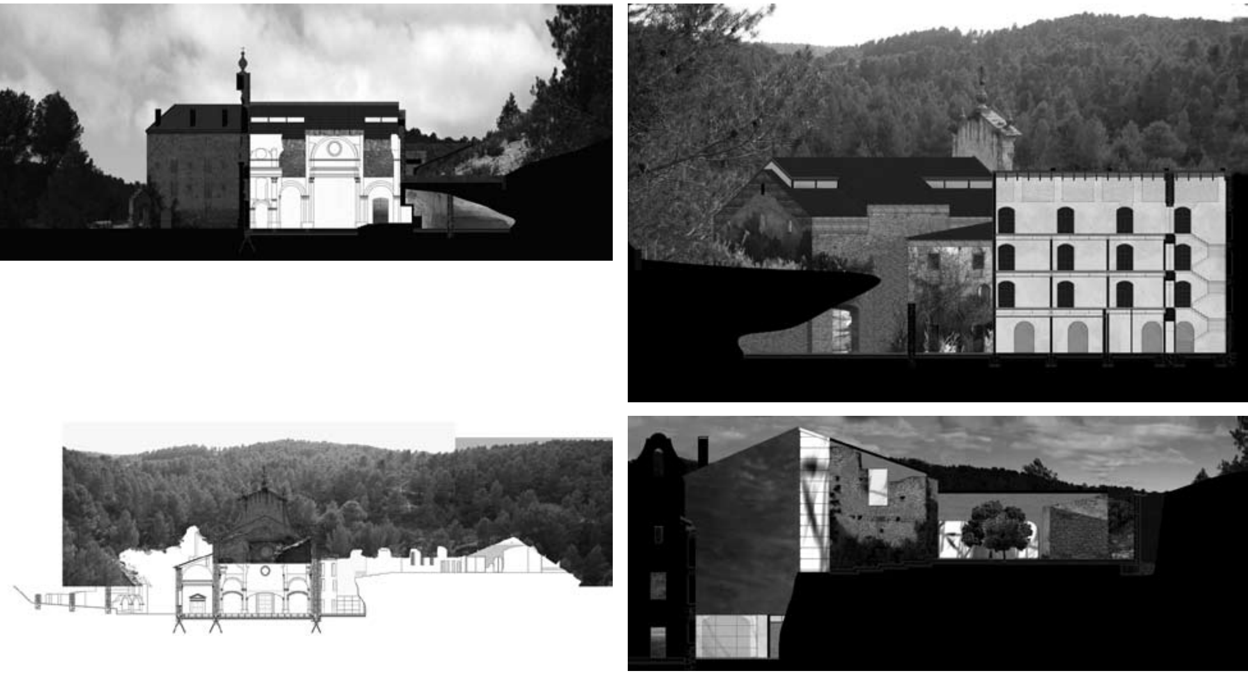

**Figure 6,7,8,9**

Renewal of an old monastery converted into a hotel. Conception and representation use the computer to design a complementary poetic contrast between the old and new parts of the building.

**Figure 10**

EXAMPLE OF ARCHITECTURAL MONOLOGICAL DESIGN

An “object” inside the old city of Zaragoza indifferent to the dialogical dimensions described in this article. There are not relationships between project and context, technology and natural landscape, mind and body experience, etc. Simply as in the case of an airplane, the object “projects” a “virtual world” directly in the real sociophysical territory. I do not see this project as an architectural progression, in spite of its “virtual” values and its technological innovations that allow to build this object in the “real” city and accomplish all technical “codes” and laws.

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**Eduardo Fernandes**

# To walk like an egyptian

## Five points in the subject of “Architectural Research and the Digital World”

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Eduardo Fernandes

# To walk like an egyptian

## Five points in the subject of "Architectural Research and the Digital World"

**1.**

In the text that first promoted the Conference that motivates this paper (the *EAAE/ARCC 2008 International Conference on Architectural Research*) there was a reference to an article in Lotus International, where Bruno Zevi claims that *the digital world represented the greatest change in conditions and the greatest potential revolution in architecture since the Renaissance.*

It is hard not to agree that we are living a great change in conditions for the practice of architecture, and today we can be sure that Zevi didn't see the end of it. But I'm not so sure if we can say that we are living the greatest potential revolution since the Renaissance, although the idea is becoming very fashionable these days: it seems to be tempting to believe that "the digital world" is so important (and will have consequences of similar importance) as the invention of the perspective drawing and the systematization of today's (or should I say yesterday's?) traditional means of presenting a project (plan, section and elevation) in the Renascence; therefore, it is appealing to consider that new means of representation changed the role of the architect in the society then, and so, likewise, today's revolution in architecture processes of conception, representation and communication will create a new architect, if it hasn't been done already…

I believe that this is an extremist point of view: History shows that *it was during the fifteenth century that architecture came to be understood as a liberal art, and architectural ideas were thereby increasingly conceived as geometrical lineamenti, as bi-dimentional, orthogonal projections*.[1] Means of architectural conception and representation changed in the Renascence because the role of the architect changed, not the other way around; the idea of architecture as a liberal art is the genesis of the modern architect, that needed new ways of communication: to show his vision to the client, to teach other how to build it, and even to test his ideas by himself; in short, to control the process of conception-communication-construction.

Today, the role of the architect is changing because of the recent evolution in his processes of work and research, not as a response to changes and needs of the present society.

**2.**

In *A Passo di Gambero*, Umberto Eco ironically states that in the digital revolution we are always looking forward but sometimes we are walking backwards: the early Internet took us back from color TV to black and white photo, the Ipod is the new radio (musicians don't like it, because of the poor quality of sound) and, with Cable TV, we are walking backwards from wireless public television.[2]

We can reinforce this Eco's image of the *Crab Walk* with the belief that, in some of the discourses about the Digital Paradigm, we are repeating the manifestos of the early XX century:[3] the period we are living is heroic; the rapid evolution, interlinking and merging of the Machines (television, computer and mobile phone) that altered all paradigms in the latter half of the 20th century is revolutionizing art and life; a great era has begun, there is a new spirit and we can feel the vertigo of the change. It's been almost one hundred years, the machines are not the same, but the fascination for the velocity of change is the same: for today's futurists, a new mobile phone surfing the net, rapidly skipping from site to site, is more beautiful than the Nike of Samothrace.

Since Marconi made it possible to hear the *sound of geography collapsing*[4] for the first time, in the very beginning of the XX century, we could see a new geographic collapse every once in a while, with the generalization of the use of radio, telephone, automobile, television, satellite broadcasting, mobile phone and the Internet; therefore, every once in a while, theory of architecture presents us with a new version of the "Esprit Nouveau" type of discourse: this is a new era, there is a new spirit, our houses and cities must change, the architect must focus on the new reality. But looking back, it is clear that we all adapt to new conditions, but neither the role of the architect in society nor the way we live in our houses and cities changed so much as it was predicted.

You should also remember that this kind of ideal vision of the future, with great confidence in the unquestionable benefits of progress and technology, was soon questioned with the disasters of the Titanic and the Hindenburg, and the atrocities in World War II (with the atomic bomb being the most paradigmatic). We all learned then that there is a black side in technology; and once again, seven years ago, the attack on the Twin Towers reminded us that changes don't occur only for the better, and that globalization also means global violence…
These are the main reasons I don't understand why today, with the so called "digital revolution", this old discourse seems to acquire a brand new sparkle:[5] by now, we should be accustomed to the fact that the most stable feature of the contemporary world is the permanent increase of the velocity of change, and beware of its consequences…

**3.**

So, if we all agree that, as it has been for the last hundred years, today's society is rapidly changing, we should not focus on the evidence of change, but on the understanding of what the main changes are.

Marc Augé defines the present as an era when time is no longer an element of intelligibility, where the plentifulness of information shows the multiplicity of events and increases the velocity of history, where the new paradigms are processes of excess and acceleration of time, space and ego.

I believe that this acceleration and excess are related to a process of digitalization of our physical reality: more and more, the life of the common people takes place in "Non-Lieux", spaces that can not be defined or related by identity and history[6], as "Generic cities" and "Junk-spaces",[7] and more and more they seem to choose "living" their dream life through Magazines, Television and Internet (where you can get a "Second Life" in more than one way).

The way we communicate is also changing fast: we now spend more time talking in mobile phones and sending SMS or email messages than actually talking to people face to face (I know I do…). Neil Leach calls it a *narcissistic condition* that defines those that live *locked into their interior worlds*, lost in *strange one-way conversations* on the cellular phone and *increasingly divorced from their immediate surroundings* on the computer. But the opposite model that Leach presents, the *Wallpaper* person*, living in *an enchanted dreamscape, an aestheticised and mythologised dreamscape*,[8] is still someone that lives by images, in a process of representation of reality. Baudrillard has the most radical vision of this phenomenon of fusion between reality and representation: he claims that we are living a *simulation era* and all of the actual forms of activity tend to a *publicity shape* (and most of them go no farther).[9]

Architecture is a good field of research for this phenomenon: it has acquired a mass medium impact in the last twenty years because everyone is interested in images of architecture. Architects, of course, give representation more and more importance every passing year and there seems to be an increasing tendency to confuse good images with good building. This is a natural trend, because the actual "star system" of the architectural milieu is working like a globalized *École des Beaux-Arts* where the image of the "project rendu" in the various "concours d'émulation" (that now occur all over the world), published in books or magazines and accessible in web sites, is the key element for the possibility of increasing the public impact of the work of an office. The best example is the great publicity achieved by Koolhaas and OMA when *S, M, L, XL* was published: in the 1348 pages of the book we can find a lot of appealing images of competition projects and few realized works.

So, like in the *École des Beaux-Arts* in the XIX century, most of the young architects of the present believe that they can use images to fulfill all their architectural ends. But the perfection of the render is many times hiding a lack of sense of construction and the deficient understanding of the site, the program or the client: it represents too many hours of work, and we all know that, in the architect's activity, time does not grow on trees…

I believe that, today, we need to understand how the Digital World can help us to focus once again on *experiencing architecture*,[10] instead of simply using it for creating projections of the reality…

**4.**

Of course we all agree that computers, mobile phones and the internet are liberation realities, and instruments that change the way you live and work in many ways. So, the present revival of the "Esprit Nouveaux" discourse can make sense, in the disciplinary field of Architecture, if you believe that the role of the digital revolution can be so important today as the introduction of the concept of "space" in architecture[11] was in the first half of the XX century: it is opening new paths, different ways of looking at things.

But if you look at the heroic period of modern architecture, you see that this new concept is related to a very large number of phenomena that occur almost simultaneously: new geopolitical conditions, great changes in the means of production and transportation, a revolution in the liberal arts, a fast modernization of society and new materials and construction techniques. I don't believe that the extent of change in the conditions of our world is comparable, today.
In the first half of the XX century the role of the architect changed, like in the Renascence, because society needed it to change. But it changed in a way that is the opposite of what is happening now: the architect became less concerned about producing great images of architecture in a *Beaux-Arts* sort of way and more interested in the problems of his society. And, of course, this was just the beginning of a process of trial and error: it was only in the last CIAM reunions that the modern architect was able to free himself from the pre-established models of the Athens Charter and become aware of the reality of his surroundings.

In Portugal, where I come from, the first awakening to the theory of modern architecture was very late, for political and social reasons: the so-called *first generation of the Portuguese modern architecture*,[12] in the late twenties, was only trying to use new materials, techniques and aesthetics in an eclectic way, and soon changed their language to the nationalist style that the fascist regime of Salazar imposed in the late thirties; it was only in 1948, in the first Congress of Portuguese Architects, that the ideas of the modern architecture and urbanism were defended by a new generation, more aware of the principles of the Athens Charter than of the reality of their poor and under-developed country, where the majority of the population still lived in a rural context. The confrontation between the international ideas of the young generation and the will to preserve a national identity by the old one seemed to be an impossible dilemma; but Fernando Távora, in his 1945 text "O Problema da casa Portuguesa", had already pointed the solution: you had to study both the international processes and the local conditions, to achieve an architecture that is both modern and Portuguese.

It was only ten years later that this “third way” had conditions to be achieved, with the *Inquiry on the Portuguese Popular Architecture*, that took place between 1955 and 1961; it was the first great moment of *Architectural Research* in the history of the twentieth century in Portugal, and the final report, published in 1961,[13] was one of the most influential documents of the century for Portuguese architects, mainly because of the impact of the images it contained, in which all the representation techniques available at the time were used: photographs, drawings, maps, typology tables, etc. This book proposed a return to the roots of popular architecture, presenting a rural society that was already in the process of disappearing: it soon became a virtual reality. But, for the ones that were involved in the process, it was a real and unforgettable experience with practical results in architectural design: it showed that traditional architecture was rational and functional, and aimed to answer the needs of their promoters in an economic way, just like modern architecture. If you see the work of Fernando Távora, before 1955 and after, you can clearly understand the influence of the *Inquiry*.[14]

The second great moment of *Architectural Research* in the history of Portuguese architecture was catalyzed by the revolution of 1974, which ended the 48 years of dictatorial government. Then, in the 25th of April, everything changed: the society became more open and the population lost their fear. Everybody went to the streets to manifest its needs and concerns, and it became clear that the need for housing was one of the most serious problems, for the lower classes. Nuno Portas, Secretary of State of Housing and Urbanism, created the S.A.A.L. program (Mobile Service of Local Support) that mobilized architects throughout the country, projecting houses for the poor in a process of direct dialogue with the final client, trying to learn from popular culture, once again.[15]

The SAAL Process was, like the Inquiry, a paradigmatic moment of identity in the School of Oporto. Everybody was involved in the process, and the School was transformed in a place of production and practical research. It was a real and unique experience: to confront the scale of the city and the scale of the needs with the will to approach every project as a unique solution for a specific client.

It didn’t last, and in 1977 the politics of economic housing were back to more traditional programs; like the Inquiry, it was an unforgettable experience for the few that lived it, and an Iconic moment for the others, this time with outstanding international impact. But if this was the first moment when the European milieu noticed the Oporto School and the name of Álvaro Siza Vieira, the image of the very few projects that were published then proposed a misleading conception of what was the SAAL, the Oporto School, and Siza’s work...[16]

I’m referring to these two paradigmatic references in the history of Portuguese Architecture since they were very important as an attempt to define it as a product of the mixture between global society and local individuality; but also because they can both be seen as a response to society needs, resulting simultaneously in a real experience, that defined the identity of our architecture in an epistemological way and as a creation of a virtual reality, that produced "styles", and originated trends that Portuguese architects explored to their limits.

This simple fact of the creation of internal references is relevant to our culture: all through the long history of our nation, Portuguese Architecture has always been the result of a combination of imported cultural values; our Architectural Research has never been a vanguard exercise or a completely original approach, but its endemic inertia favors changes in the way it applies imported models or systems, in the way it adapts them to the Portuguese reality: this is the main feature of our specificity.[17]

But in today's globalized world, this condition has changed: not only all of the western countries live in a combination of foreign cultural values (and so this mixture can no longer be considered a unique feature of Portuguese specificity), but also our reality is now no longer much different from the other European Countries: Portugal has evolved from a rural society to an urban and modern culture. Facing the Digital World, Portuguese Architecture finally has the conditions to surpass our endemic inertia in the modernization of the processes of Research, Conception, Representation and Construction, but is lacking the response to what has been, since the beginning of the XX century, a permanent obsession in our Architectural Research: the knowledge of a Portuguese specificity.

Aware of this new condition, the most famous Portuguese architects have learned to place themselves in the globalised market, playing their role in the new *École des Beaux-Arts*, producing great images without losing the real qualities of their work, as architectonic facts.
Álvaro Siza Vieira has made a career emphasizing the Portuguese character of his Architecture, mixing recognizable international references, adapting imported theories, models or systems to his critical view of the reality of the sites; the images of his work are often misleading, and sometimes tend to a *publicity shape*, but the real qualities of his work appear when you visit the building: most of his work has the *quality without a name wich is the root criterion of life and spirit in a building*.[18]

Eduardo Souto Moura has developed a different path. The images of his work are very close to the reality of the buildings, so you are seldom surprised when you visit the actual site; the paradox in his work is that the construction itself that can be appealing as a architectonic fact and as a simulacrum of reality,[19] a projection of an ideal world. Mainly in his houses, I see the materialization of a publicity shape, created to appeal to the *Wallpaper* person*...

Searching for a Portuguese specificity in the work of their masters, the new generations try to follow their footsteps, with more or less understanding of the meaning of the images they create. But I believe we are lacking a new paradigmatic moment in architectural research, to offer young Portuguese architects a new confrontation with reality…

**5.**

“Walk like an Egyptian” is the title of a pop song, which I’m sure you all know…
According to the Wikipedia, composer Liam Sternberg wrote it after seeing a group of people on a ferryboat, walking awkwardly to keep their balance, which reminded him of figures in Ancient Egyptian reliefs. The song was recorded in 1986, by a pop group named Bangles, whose success was mostly based on the appealing image of its female members; it was regarded as a joke by the band, but became a hit and was one of the reasons why the album *Different Light* was the most successful record of the group. “Walk like an Egyptian” is still a popular song today, and the video is often showed in VH1 and one of the most visited in the “YouTube”.

Of course, everybody knows that ancient Egyptians didn’t walk like that, but this perception, which was already reflected in other items of popular culture, acquired an accepted meaning after 1986: *walking like an Egyptian* is to make a fool of yourself moving sideways, in a strange and funny manner that looks like you’re dancing on the sand.

I used the name of this song in the title of my paper for two reasons:
First, because it is a good example of the processes of information in the digital world: it starts with a misleading popular notion, based on an ironic and erroneous interpretation of images, intentionally disregarding the specific context and representation techniques involved in the media of representation; then, someone writes a song about an everyday episode that has nothing to do with the original subject using that misleading notion with a different ironic approach; then, a pop group (whose success is mostly iconographic) decides to use it as a joke and explore the theme in the video, appearing in such a pose and showing normal people doing what they call “the sand dance”.[20]

As a result of this process, the iconic popular notion was transformed into a second-hand reference and the original irony became a sarcasm disguised as a pantomime: most people like the song because it showed them a new way of looking silly when they went dancing in a disco club, while the Bangles laughed all the way to the bank. Today, if you say “Walk like an Egyptian”, the memory of ancient Egyptians only comes to mind after you think about this “sand dance”: the song and the video appropriated the notion and the new meaning was globalised in the media since 1986, and is still very strong today. In short, I’m using this example to say that the misleading of the media of representation started five thousand years ago but is much stronger today: with the processes of handling information of the digital world, you can very easily lose track of time, meaning and judgment.

The second reason why I have chosen this title is the belief that today, in my country, it is very easy for those who are involved in *Architectural Research* to be either looking forward while walking backwards, or looking backwards while trying to walk forward. If you focus on the velocity of change, it is tempting to look at the digital world as a paradigm in itself: as an end, not as a means. You end up using all of your energy and knowledge in the process of finding new uses for all the brand new digital technology and to keep up with all the advances in the field; in this process of permanent learning, you abandon the one-year-old devices and software that you didn't have time to explore to the limits of its potential and start exploring the brand new ones, again and again, disregarding all of the disciplinary knowledge in the architectural field that is not directly influenced by the evolution of digital technology.

On the other hand, if you focus on the traditional instruments of *Architectural Research* you risk refusing to see how technology can help achieve a better understanding of the architecture of the past and the necessities of the present and immediate future. This is still a tempting path, in the School of Oporto, where our traditional endemic inertia is treasured as an identity attribute, the only thing that still distinguishes us from the rest of the world.

So, I believe that Portuguese architects can, once again, search for a third way: we should try to *walk like an Egyptian*, looking around, dancing on the sand of digital technology without the fear of looking silly, moving sideways between global and local, technology and tradition, reality and simulacrum, images and architectonic facts.

## Notes

1 Pérez-Gómez, Alberto, "The revelation of order. Perspective and architectural representation" in Rattenbury, Kester (Ed.), *This is not architecture*, New York, Routledge, 2002 (p.6).

2 Eco, Umberto, *A Passo di Gambero*, Milan, Bompiani, 2006 (p. 6-7 of the Portuguese edition: *A Passo de Caranguejo*, Difel, 2007); I can add to this Eco's discourse that LP records in vinyl are fashionable once again: the last electronic device that I have purchased, early this year, was a record player…

3 Among many others, I suggest: Marinetti, *Le Futurisme*, Paris, 1911; Corbusier/Ozenfant, "Domaine de l'Esprit Nouveau", *L'Esprit Nouveau*, nº 1, Paris, 1920; Corbusier, *Vers une Architecture*, Ed. Crés, 1923.

4 FAT, "Everything counts in large amounts (The sound of geography collapsing)" in Rattenbury, Kester (Ed.), *This is not architecture*, New York, Routledge, 2002 (p.6).

5 See, for example: Garreau, Joel, *Edge City*, New York, Anchor Books, 1988; Ascher, François, *Metapolis ou l'avenir des villes*, Paris, Odile Jacob, 1995; Mitchell, William, *E-topia: "Urban life, Jim; but not as we know it"*, Massachusetts, M.I.T.,1999.

6 Augé, Marc, *Non-Lieux*, Éditions du Seuil, 1992.

7 Koolhaas, Rem, "Generic cities" in Koolhaas, Rem; Mau, Bruce, *S, M, L, XL*, New York, Monacelli Press, 1995; Koolhaas, Rem, "Junk-spaces" in Koolhaas/AMO/OMA/&&&, *Content*, Köln, Taschen, 2004.

8 Leach, Neil, "Wallpaper* person. Notes on the behaviour of a new species" in Rattenbury, Kester (Ed.), *This is not architecture*, New York, Routledge, 2002 (p. 232-233).

9 Baudrillard, Jean, *Simulacres et simulation*, Éditions Galilée, 1981.

10 I am referring directly to the book of Steen Eiler Rasmussen (*Experiencing Architecture,* Massachusetts Institute of Technology, 1986) but there are similar ideas in the work of Gordon Cullen (*Townscape*, Architectural Press, 1961), Christopher Alexander (*The Timeless way of Building*, New York, Oxford University Press, 1979), Herman Hertzberger (*Lessons for students in architecture*, 010 Publishers, Rotterdam, 1991) and many others.

11 See the work of Siegfried Giedion (Space, *Time and Architecture*, 1941) and Bruno Zevi (*Saper vedere l'architettura,* 1949 and *Storia dell'architettura moderna*, 1950).

12 Portas, Nuno, "A Evolução da Arquitectura Moderna em Portugal: uma interpretação", chapter XV of the portuguese edition of Zevi, Bruno, *Storia dell'architettura moderna (História da arquitectura moderna*, Lisboa, Ed. Arcádia, 1970).

13 S. N. A., *Arquitectura Popular em Portugal*, Lisboa, Sindicato Nacional dos Arquitectos, 1961.

14 Fernando Távora (1923 – 2005) was one of the architects that worked in the *Inquiry,* as the responsible for the research in the region of Minho, Douro Litoral and Beira Litoral. He once said "I am Portuguese Architecture"; it was ironic, but if you think of the fifties it was also very much true. You can see his work in Esposito, António; Leoni, Giovanni, *Fernando Távora, opera completa*, Milano, Electa, 2005.

15 About the SAAL process, you can see various articles published in the European architectural press in 1975 and 1976: *CAU Construccion Arquitectura Urbanismo* nº 30; *Citá Classe* nº 4; *Lotus International* nº 13; *L'Architecture d'Aujourd'hui* nº 185; *Casabella* nº 419. If you can read Portuguese, see also Portas, Nuno, "O Processo SAAL: entre o Estado e o Poder Local" in Revista de Crítica de Ciências Sociais, nº 18/19/20, Fev. 1986; Portas, Nuno, "O Serviço de Apoio Ambulatório Local / SAAL – como processo autogestionário no serviço público" in *Cadernos de Intervenção Social*, nº 2, Set. 1979; Costa, Alexandre Alves, "A Ilha Proletária como Elemento Base do Tecido Urbano" in *JA – Jornal Arquitectos*, nº 204, Jan./Fev. 2002; Costa, Alexandre Alves, "O Elogio da Loucura, 1974-1976", in *Textos Datados*, Coimbra, e|d|arq, DA FCTUC, 2007; Bandeirinha, José António "Processo SAAL, o direito à arquitectura" in Figueira, Jorge (et. al.), *Porto 1901 / 2001*…; Bandeirinha, José António, *O Processo SAAL e a Arquitectura* no 25 de Abril de 1974, Coimbra, e|d|arq, 2007.

16 Paulo Varela Gomes says that Siza flies to Berlim in the winds of an equivocation ("Arquitectura, os últimos vinte e cinco anos" in Pereira, Paulo, *História da Arte Portuguesa,* 3º volume, Lisboa, Círculo dos Leitores, 1995, p. 565) because the SAAL process brought him the label of "specialist in social housing" that Siza himself recalls and rejects (see Cruz, Valdemar, *Retratos de Siza*, Porto, Campo das Letras, 2005, p. 101).

17 Costa, Alexandre Alves, "Notes pour une caractérisation de l'Architecture Portugaise" in *Architectures à Porto*, Liége, Pierre Mardaga, 1987.

18 Alexander, Christopher, *The Timeless way of Building*, New York, Oxford University Press, 1979 (p. ix-x): "(…) There is a central quality which is the root criterion of life and spirit in a man, a town, a building, or a wilderness. This quality is objective and precise, but it cannot be named (…) when a building has this fire, then it becomes a part of nature (…) its parts are governed by the endless play of repetition and variety created in the presence of the fact that all things pass."

19 In the Caminha House (1991-98), for example, Souto Moura proposed a new modulation of the site, using the same rocks of the existent walls: as a result of this profound earthwork (that cost more than the construction of the house) the site looks like it was not touched by the intervention (see the project and Souto Moura coments in ESPOSITO, António, LEONI, Giovanni, *Eduardo Souto Moura*, Barcelona, Ed. Gustavo Gili, 2003).

20 "All the old paintings on the tombs, they do the sand dance don't you know" are the first verses of the song.

Tanja Herdt

# Fun, Power and Control

## The Change in the Idea of Power in the Architecture of the Information Age. The Fun Palace of Cedric Price, 1961–1967.

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# Fun, Power and Control

## The Change in the Idea of Power in the Architecture of the Information Age. The Fun Palace of Cedric Price, 1961–1967.

At the award ceremony of the Kiesler-Preis 2002 a journalist asked Cedric Price what he would consider the three most important criteria for good architecture. Cedric Price replied: "Fun, delight and change."[1] "Buildings", he said, "should adapt according to their users." In other words, the architect should design architecture that should be delightful to use and adaptable for change.

In order to address the challenge of the digital age to the discipline of architecture and architectural research this paper examines how the digital began to be integrated into architecture at the start of the information society. Taking Cedric Price's Fun Palace project, 1961–1967, as an example, we will discuss the disappearance of the physical presence of architecture for the benefit of social interaction and identify some of the challenges that were produced by this shift.

The Fun Palace project, 1961–1967, was one of the first projects that the young 27-year-old architect Cedric Price designed. While it is still to be discussed whether it was supposed to be a conventional building or a visionary experiment dedicated to London's architectural circles, the point of interest here is that the Fun Palace seems to have been one of the first projects having started to comprehend the challenges that accompany the "architecture of the digital age". In our days the implications of the technological change created by mass media can be observed with all their consequences. Conversations about blogs and W-LAN access points are part of our common language. We use computers and the internet with its different modes and scales of interaction as basic elements of our everyday social interaction. Looking back at the start of this technological era, the Fun Palace shows how deeply this change affected the discipline of architecture, its methods and strategies in how to build and how to control space.

According to the few plans and images that exist of the project the Fun Palace has often been described as a machine-like open structure that was to create different spaces by the use of mobile units. However, the majority of graphical documentation of the Fun Palace is in form of matrices, not showing the program of the building in form of plans or sections but as a function of size and turnover.[2] In this sense, the drawings of the project do not conform to the standard conventions in the discipline of architecture.

Another breach of convention seems to be lack of single authorship. Although Cedric Price is the architect of the project many of the project ideas were developed by and discussed within teams of experts, i.e., interdisciplinary groups that were dedicated to different tasks. The so called Cybernetic-Committee and its several sub-committees seemed to be concerned with the question of how to use and how to organize the physical structure of the building. They formed committees

that worked on particular aspects of the design like 'Form and Amenities', 'Cybernetics' or 'Form and Finance'[3]. Instead of a client, the project had a director who was the theatre-maker Joan Littlewood[4] and the Fun Palace project had its own "Fun Palace trust", under whose board members were such famous personalities as Yehudin Menuhin or Buckminster Fuller.[5]
In order to appreciate the architectural 'set-up' of the Fun Palace, considering it as avant-garde project that operated at the cutting edge of technology, it is important to take into account the building's different ways of representation, its organization, as well as the idea of the collective, even if such terms may not be within 'standard conventions' of architectural analysis. For the purpose of this analysis we propose the analogy of 'hardware' and 'software' to distinguish different design purposes. The 'hardware' of the Fun Palace deals with the requirements of the physical structure, while the building's 'software' is the interactive program designed to create different uses and atmospheres in the building. These two frameworks are closely linked to each other. Like computer hardware, the physical structure of the Fun Palace can not function without the program operating it. While the hardware/software interaction of the Fun Palace may challenge a standardized view of how to approach architecture both in terms of use and in terms of design, a proper understanding of the idea of the building does not seem possible without acknowledging these two domains and their interaction with each other.
In these terms, it is not astonishing that it is the 'software' part of the building that uses multiple authorship and which is varied in shape and form. More then 22 experts – mathematicians, sociologists, journalist, musicians, artists and politicians – were involved in the conception of the Fun Palace[6] giving rise to a wide variety of interpretations of the Fun Palace. For the theatre maker and director of the project Joan Littlewood, the Fun Palace was to be a new platform for social self-awareness and experimental theatre. For the scientist involved in the project, like the cybernetician Gordon Pask, the Fun Palace was to be a network-based cybernetic system, as much as, for Roy Ascott, a piece of interactive media art. According to their distinct visions and ideas for the project these experts opened up a discussion on new ways of interrelation between the physical and the virtual, or the individual and the collective. By doing so they discussed as well the limits of choice and interaction and the rights of the individual within the community. The various interpretations of the design of the building's 'software' will be the main focus of this paper.

## HARDWARE

In 1962, the year when the Beatles released their first single, Love Me Do, London's architectural scene was already riding the gentle wave of pop. The young Archigram group of architects published in their magazine their first collages of the 'Plug-In City'[7], showing a scaffold-like structure for a shopping centre in Nottingham, emblazed with logos of Pepsi-Cola, Hoover and Burnett's Gin. Around the same time, in London, Cedric Price and Joan Littlewood had published a brochure to call for donations to build a very similar project, which they called the 'Fun Palace'.
According to the fundraising leaflet the 'Fun Palace' was to be a place where everyone could "Choose what they want to do, or watch someone else doing it, learn how to handle tools […] dance, talk or be lifted up, where you can see how other people can make things work."[8] On

the inside of this fundraising leaflet were several diagrams and drawings of the building that showed the location of the Fun Palace, its connections to transport as well as different program suggestions. In the section perspective, which filled the two inside pages, the Fun Palace looked like a giant machine. It was basically a large open steel structure, ten stories high, on top of which two large cranes were placed that could move around the different event spaces of the building.

The Fun Palace was supposed to be an open structure in two ways: literally open, without facade, more a park than an indoor space, and open in program and use. Joan Littlewood compared the idea of the Fun Palace with a three dimensional park. Envisioning a place that is flexible enough to accommodate all sorts of activities and open enough to host all "social classes". "The whole plan is open but on many levels. So the greatest pleasure of traditional parks is preserved – the pleasure of strolling casually – looking in at one or another of these areas..."[9] As the headline of the brochure suggests, it was the "FIRST GIANT SPACE MOBILE IN THE WORLD it moves in light turns winter into summer….toy….EVERYBODY'S what is it?"[10]

Im comparison with the atmospheric language describing the building the presentation of the building seems to be very abstract and schematic. According to the plans the building was to be a steel structure not unlikely the structures used in shipyards. Additionally the Fun Palace had two concrete service towers and a flexible textile enclosure to cover the roof. Attached to the steel frame were prefabricated enclosures that formed special service rooms[11] as well as all kinds of technological equipment from air curtains over screens and displays to a movable cleaning facility for the frame itself[12]. However, the whole structure, while having a strong visual effect dominating it's surrounding with its massive dimensions, did not show any sign of cooperate design. There exists no interior design concept for the building, and in fact there is little evidence that there was made any attempt to give the building a strong formal expression by designing a facade or any further materialization. It seems instead that efforts were made to reduce the aesthetic expression of the building as much as possible. As Steven Mullin, one of the project architects of the Fun Palace has put it: "He (Cedric Price) went so far that he insisted in eliminating the form as an element of representation. He destroyed the beauty of architecture and substituted it with the beauty of the user."[13]

## SOFTWARE

Joan Littlewood began with her Theatre Workshop to travel by bus through the countryside and to stage a workers' theatre very close to Brecht's social ideals.[14] In 1960 she was on the peak of her career playing with the Theatre Workshop in theatres in London. According to her autobiography[15] she met Cedric Price at a party in London where she told him about her idea to build a permanent stage that would overcome the fourth wall, i.e., the separation between actors and audience. It was to be interactive by engaging the people to participate in the play, and it was to be educational by making the audience judge what they had seen.

Soon after their first meeting Price started work on was to become the Fun Palace. From 1962 to 1967, he and Littlewood worked closely together refining the design and premise of the Fun Palace.

Littlewood referred to it as ‘a university of the street’[16]. Like the Alexandra Palace, a glass building that was built in 1873 in London’s North, the Fun Palace was also meant to be an example of the world’s great technological achievements and another ‘People’s Palace’. However, as the name ‘Fun Palace’ make clear, activities within the building were meant to be primarily enjoyable. Its purpose was fun and enjoyment of any sort. The range of activities that were to take place in the Fun Palace included features like ‘gossip revues’ where you could chat and talk about what was going on in your neighbourhood[17]. There were to be teaching facilities, a ‘science gadgetry’ and a ‘genius chat’[18]. Some high-technology activities like “life broadcasting from TV screens”[19] that would allow users to watch themselves interacting with other people inside the building relied on technological advances still to be made. There were also surprisingly romanticizing activities like fireworks or stargazing[20]. One can take this list, which is far from complete, as a sign that the huge machinery was not only programmed to facilitate certain preconceived activities but also to create a certain mood, create situations of enjoyment and provide inspiration for the spontaneous use of the facility. The machine is not only programmed to do certain things but it is a machine creating atmospheres that people react to emotionally. “The activities designed for the sight should be experimental. The place itself is expendable and changeable. The organization of space and objects occupying it should, on the one hand, challenge the participants mental and physical dexterity, and on the other hand, allow for the flow of space and the time in which passive and active pleasure is provoked.”[21] Price and Littlewood envisioned a space that was accessible at all times.

With this program they tried to convince the government to fund the Fun Palace and the London authorities to allocate a building site.

### Architecture as Organization

Part of the planning for the Fun Palace was done by a committee called “the cybernetic committee” formed out of consultants with as different professional backgrounds as psychologists, sociologists, engineers, and mathematicians.[22] They designed a cybernetic concept of response and reflex, which was to control the spatial arrangements of the Fun Palace according to the users’ preferred activities.[23] They tried to achieve true interaction between men and the machine of Joan Littlewood’s vision. Gordon Pask, a good friend of Cedric Price and a consultant for the Fun Palace project, stated that architectural design should foster a productive and pleasurable dialogue on all scales. With his technical background Pask cast this task in terms of cybernetics, i.e., the science of control within any assembly that can be treated as an organic whole.[24]

Pask developed learning environments that viewed the human as part of a resonance between men and the environment. He wanted architecture to comprehend itself as one of the fundamental conversational systems in human culture. In his ‘Five guidelines of the cybernetic theory of architecture’ he wrote that “concepts of very different disciplines will be unified with the concepts of architecture to yield an adequately broad view of such entities as ‘civilization’, ‘city’, or ‘educational system’.”[25] Learning, observation and prediction were the three aspects, which characterized the cybernetic system that should make the Fun Palace function. It was a holistic view: The system entirely determined all characteristics of its elements, including the relationships between its constituents. It operated in a range of scales from local to global, connecting the aspects of culture and society with the political and the physical aspects of architecture. “Systems, notably cities, grow and develop and, in general, evolve. Clearly, this concept is contingent upon functionalist hypothesis. […] An immediate practical consequence of the evolutionary point of view is that architectural design should have rules for evolution. […] The novel sub-theory is that structures may be designed (as well as intuited) to foster a productive and pleasurable dialogue.”[26]

In that sense the Fun Palace was part of a larger network. It was designed not only as a cultural centre but also as an information hub that connects the local with the regional with the national. In fact, it was to be at least as much infrastructure as it was to be a ‘mere’ building. A wide variety of access, by an underground connection, a train station, a hovercraft port and local access for pedestrians, should both allow random 24-hour use of the facility by everybody and provide supra-regional connectedness. “This complex, which enables self-participatory education and entertainment, can only work – and then only for a finite time – if it is not only accessible to those who live and work in the immediate neighbourhood but also, through its varied communication links, accessible as a regional and national amenity.”[27]

There is even evidence that the committee members of the ‘Form and Amenity’ group envisioned something similar to the internet, which was to be invented and realized a few years later. They planned an interactive information display in form of pillar that connects and displays the Fun Palace users to the world and vice versa. They considered if and how they ”could plug into existing equipment, or start a national grid of information covering all universities.”[28]

Furthermore, from its inception, the Fun Palace was thought of as one part of a larger system of similar installations all over the country or even worldwide. The leaflet suggested other Fun Palaces in Liverpool, Tokyo, Chicago or Odessa.[29] Being inside the Fun Palace should feel like being part of something bigger. It meant being connected to both the world and to one’s own desires.

The writing of the brochure seems to underline this personal appeal, using a language of play and event. The text does not mention functions and uses. It does not discuss machinery either. Instead, the Fun Palace was described as a “living toy”[30].

In Littlewood’s and Price’s argumentation the word ‘fun’ is connected to the right for education, self-experience and creativity. The access to information is the most important goal of their ‘fun’ architecture. The Fun Palace is simply a structure that provides users with access to technology and public space. The architecture makes the attempt to serve as an informational infrastructure that connects the virtual network of information to the community and the neighbourhood.

## Architecture as Game and Play

However it is still unclear what the nature of fun would have been. With the development of the project came the need to define specific types of uses. The committees that sought to develop the ideas of the program tried to identify the characteristics of fun in the building: They “wanted to get closer to a definition of ‘fun’… Roy Ascott […] suggested ‘seeking the unfamiliar’, and ultimately ‘transcending the unfamiliar’. Fun Makers provide amenities, which are unfamiliar. Funsters have the ability to seek the unfamiliar.”[31]

Since being confronted with the unfamiliar, often is – temporarily, at least – accompanied by a certain level of stress and even discomfort, this seems quite different from today's leisure industry with its emphasis on wellness and relaxation. Whereas leisure-and-entertainment facilities today tend to provide specific commercialized types of fun, often offering rather passive enjoyment in specifically designed comfort zones, the Fun Palace idea of fun is to specifically provide the opportunity to investigate your own limits, alone or together with others.

The committee invented games that should provide these situations: "We […] began discussing the nature of fun and the way in which appetites can be created […] ideas such as the teaching machine facility and an identity bar where visitors could obtain clothes in order to modify their identity and to try out new social roles. Ascott stresses the need for facilities that would enhance the social awareness of visitors to the Fun Palace."[32]

One of these games that the Fun Palace should have hosted for random interaction was the "Two way panto" an interactive pantomime that worked with a screen that "signify the […] arrival of the Wicked Uncle. If the audience booed, the shadow would hover indecisively, if the audience booed louder the shadow would start to shrink. […] The pantomime would need to be scripted with a capability for branching in one of two possible directions according to audience reaction."[33] The game had only two possible outcomes, which were the disappearance of the shadow and its dominance over the whole surroundings.

This game was intended to make people interact and experience a feeling of togetherness. The game appealed to the solidarity of the people, as they should act against a mysterious shadow. The game thus makes a strong moral and educational attempt, which may be seen in conflict with the proclaimed idea of individual freedom and open interaction.

In the next meeting of the 'Form and Amenities' committee the questions and doubts of how to provide openness and freedom within a preconceived system like the Fun Palace had been discussed. The committee members were well aware of the restrictiveness of their inventions: "John Clark cited the need for providing physical and emotional thrills and for satisfying the individual's desire to exhibit himself and to extend his sense of power and feel the sensation of sinking into a group. All these issues raised questions of morality and legality…"[34]

**Architecture as Social and Political Interaction**

The point about which the discussion arose is that openness and control can be seen as being mutually dependent: "On what stage do we say: 'You can not do that', or is control affected by the nature of amenities? Pask thought it should be affected by the amenities and the control system: 'In the Fun Palace you don't get thrown out into the street if you don't fit into a particular group, you pass on to another group.' Ascott said that people in a community have all kinds of values, which need to be channelled […] Clark said that people have been induced to join organisations by setting up a mythical history of the organisation."[35]

And indeed the Fun Palace Cybernetic sub-committee thought about special games that could enhance the level of identification with the building. In the journal New Society they wrote: "We would like to generate a hard core of Fun Palace devotees who would return, again and again, and help to control the place… In order to cultivate such a group we have to introduce a hierarchical system of privileges associated with frequency of attendance and overall performance in the system."[36]

They suggested several games like the test of loyalty that "by passing appropriate tests of loyalty and ability, every visitor [would be] entitled to be initiated into the highest mysteries of the organization. […] We may also endow the Fun Palace with a mythical history, and scatter icons about to symbolize […] the objectives for which it was founded."[37]

Reading the minutes of the meetings in spring 1965 it seems that the discussion over control systems overshadowed the architectural project. The idea of control dominated all other achievements that the Fun Palace could have brought. Whereas Littlewood and the 'Form and Amenities' committee's ideas of program were based on channelled interactive games, the "Cybernetics committee" put emphasis on social control that was executed by the system. As Pask has put it in his 'Five guidelines of the cybernetic theory of architecture': "There will be a proper and systematic formulation of the sense in which architecture acts as a social control…"[38]

However, the lack of explicit control raises the question of how the intimate use of machines and technologies influences our behaviour and us as human beings. It is not so clear anymore what is object and what is subject within this automated system controlling social life.

It is Gordon Pask who lays the responsibility and the power of control to the machine itself. "Let us turn the design paradigm in upon itself; let us apply it to the interaction between the designer and the system he designs. […] Notice the trick, the designer is controlling the construction of control systems and consequently design is control of control. […] Further the design goal is nearly always underspecified and the controller is no longer the authoritarian apparatus."[39]

In contrast, the 'Form and Amenities' committee relied on social interaction by suggesting to install social observation: "Another point that appeared in discussion was the capability of observers. […] The testing of initial hypotheses will depend upon the capabilities of men acting as observers. How capable are they in practice? It was agreed to assign this issue to a special psychological group."[40] The committee may not have shared entirely the believe in men that the initiators of the Fun Palace had. They thought some form of control was necessary.

With the experience of various socialist regimes, which were already available in the 1960s, we may wonder how naïvely the means of control (citizens controlling and judging citizens) and the trickery to 'inspire' loyalty were planned to be employed. On the other hand, looking for instance to Disney Theme parks, one can easily find some sort of artificially created mythical identity. Many other examples could be named. Also the way in which Gordon Pask was willing to hand over the authority to the system itself is something that we can easily observe today.

Considering the high intentions we have to ask: How could that have happened? They wanted to leave freedom to the users of their building but they didn't trust the users to actually be able to handle this freedom.

## CONCLUSION

The Fun Palace project ultimately failed. The most immanent hurdle was lack of public support – partially due to miscommunication between the project leaders and the community. However,

more importantly, it is doubtful whether the technology was ready to fulfil what the project demanded. Compared to technological opportunities of the early 1960s today's electronic systems are much farther developed, which makes it easy to believe that the visions of the Fun Palace could now be set into practice. Would it work today?
The focus of this contribution does not lie in the technological problems or the solutions thereof. It rather lies in the general social questions raised by the various Fun Palace committees: How to allow open access and what degree of control to keep are questions that are still challenging. It is not to present answers, but merely to draw attention to the unique 'mechanics' at work in the Fun Palace to address these issues, for the top down approach of the 'Fun and Amenities' committee has as little appeal as Pask's form of handing the control over to the system itself. The idea of participation was to be extended such that the users controlled the processes of the Fun Palace and its program. They would have to take responsibility and their desires and needs would invariably change. Whereas classical buildings mirror a specific situation or functionality in time the Fun Palace tried to mirror the process of social interaction. It therefore would have been open-ended by design.

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# Between Analogue and Digital Diagrams

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# Between Analogue and Digital Diagrams

**Abstract**

This essay is about the interstitial. About how the diagram, as a method of design, has lead from the analogue deconstruction of the eighties to the digital processes of the turn of the millennium. Specifically, the main topic of the text is the interpretation and the critique of folding (as a diagram) in the beginning of the nineties. It is necessary then to unfold its relationship with immediately preceding and following architectural trends, that is to say we have to look both backwards and forwards by about a decade. The question is the context of folding, the exchange of the analogue world for the digital. To understand the process it is easier to investigate from the fields of art and culture, rather than from the intentionally perplicated[1] thoughts of Gilles Deleuze. Both fields are relevant here because they can similarly be used as the yardstick against which the era itself it measured. The cultural scene of the eighties and nineties, including performing arts, movies, literature and philosophy, is a wide milieu of architecture. Architecture responds parallel to its era; it reacts to it, and changes with it and within it. Architecture is a medium, it has always been a medium, yet the relations are transformed. That's not to say that technical progress, for example using CAD-software and CNC-s, has led to the digital thinking of certain movements of architecture, (it is at most an indirect tool). But the 'up-to-dateness' of the discipline, however, a kind of non-servile reading of an 'applied culture' or 'used philosophy'[2] could be the key.

*(We might recall here, parenthetically, the fortunes of the artistic in contemporary mass society. The proliferation of museums, the magnification of the figure of the artist, the existence of a massive consumption of printed and televised artistic images, the widespread appetite for information about the arts, all reflect, of course, an increasingly leisured society, but also relate precisely to the fact that, faced with the tedium of everyday, real, lived experience, of the scientific illusion, of work and production, the world of art appears as a kind of last preserve of reality, where human beings can still find sustenance. Art is understood as being a space in which the fatigue of the contemporary subject can be salved away.)*[3]

**Cultural embedment**

We must also consider those significant historical-political changes that took place during the examined time. From a certain point of view, both Central and Eastern Europe were responsible for the death of postmodern feeling. The world which had been divided into three parts, or let's call it a 'three-fold world', at one stroke became dual but without a counterpart, without an alternative that had existed more or less in the image of socialism. The Promised Land seemed to be guaranteed by liberal democracy. The 'double code', a privilege of the Western world, immediately belonged to everybody. The whole of the East accepted it, it had to be accepted with all the attached factors (capitalism and ideology) in a big system-package[4]. In this endless pluralism, in the 'end of history'[5], it was not an option to separate politics from economy, arts from society, even architecture from culture. It could have result in a kind of singularity of the individual: the respect of alternative lifestyles, ways of thinking and 'otherness' held the promise of very heterogeneous societies. Then it was obvious, or rather a commonplace, to consider this unified world as a field of contradictions. Confronting ourselves with the oppositions of totalization and freedom, uniformity and pluralism, global and local, is inevitably embarrassing. That is why artists and theorists use a contrasting method of criticism instead of creating an ordered one.

Meanwhile there is no doubt that the electronic had exceeded the old mechanic spirit and had dominated culture, and in recent years the same has happened with the digital over the electronic. So parallel with the above-mentioned annulling of the absolute reference points in thinking, its image in art disconnected from reality. The non-closed and incomplete world cannot be represented anymore. In the 'post-classical' era everything, hence image and architecture is information that cannot be shaped by traditional tools. That is why it is very important to seek for new forms.

Until the end of the 1980s, in thinking as in the material territory, the whole world was constructed from single elements that barely changed or transformed for thousands of years. The creating technique was to do nothing other than to superpose or juxtapose these parts to an integration from ancient times to postmodernism. Jeffrey Kipnis affirmed in the early 1990s that it was said that we have 'exhausted the possibilities of forms', we can only choose from the received catalogue of them: 'It seems to me that every indication [of form] today is to the contrary; whether one considers the political transformations in Eastern Europe or the technological transformations that characterise today's society. The building of the catalogue of available forms, aesthetic forms, institutional forms and of forms of social arrangement, has only just begun.'[6]

Hence extensive research has to be undertaken based on the fundamental metamorphosis of understanding history, politics and economy. This research started more easily in other disciplines of art and resulted in 'contemporary answers'. In the second half of the twentieth century, in opposition to the 'empty plot' of modernism, archeology seemed to be a relevant device to withstand uniformity and make a kind of continuous history. Michel Foucault and Jacques Derrida explained the world as historical and cultural layers heaped one on top of the other and they regarded the 'actual present' as rereading and restructuring the system. This build-up contained then traces from the past, all known pieces in new relationships. So coming closer to the turn of the millennium, searching for any kinds of new forms (figures, frames, structures, programs, etc.) inevitably has to supersede superposing existing systems, even deconstruction, the last layering hero. Therefore in the nineties it was a declared purpose, during alternating decon, to kill the collage. Gilles Deleuze's rhizomatic thinking and folded forms appeared to be adequate to achieve this goal. Both of them, deconstruction and folding, were warriors against the territory of depleted clichés and conformism. They fought on the same side, but while the first was limited ('to a particular order of semiotic recombinations'[7]) and was not able to manage its power over its heterogeneity, the latter was trained against a bunch of enemies to maintain a seem-to-be-organic, complex empire that was still constructed from existent contexts.

According to the popular pendulum or spiral metaphor of cultural theory, the angular shape of decon needed to be followed by the round shape of folding: simplifying art history and reducing it to pure form, a cyclical method can be discovered over the centuries. Eras, styles and then trends were swinging from one pole to the other. As Mario Carpo stated in the nineties, after the strict, sharp, angular forms of decon, the smooth and curved 'dominated industrial design, fashion, furniture, body culture, car design, food, critical theory in the visual arts, sex appeal, the art of discourse, even architecture'[8]. So the change is not questionable from this point of view, it was necessary to smelt the old warrior into a brand new structure of a flowing mass. And there is another cyclical theory of structure or the shape of structures, similar to manmade forms: a differentiated, shown or visible system (decon) and an integrated, hidden or invisible one (folding) alternate with each other. But the cultural metamorphosis near to nowadays is not just about form or structure; these are only some of the results of changing paradigms. The shift from the stable, unambiguous, solid space to the pulsating, always-becoming, event-based media space has influenced and has been influenced by architecture, as well as other disciplines. All of them are dissolved in a huge net, a rhizomatic system, the above-mentioned space-model. This process started with the theoretical deconstruction of the existing elements, blowing them up and trying to create a new structure, but partially using old methods like collage. Folding therefore wanted to reconfigure the pieces into an anti-classical new whole, but partially in the old, 'real' world.

**Deconstructing history**

Deconstruction asked questions about basis and structure, about the forces that keep the system together. It criticized and argued all existing and dominating structures and books of rules, not with the intention of erasing them, but to re-evaluate and twist them. Questioning is the most significant motive behind deconstruction: uncovering traces and relationships from the past, while always also questioning the discipline itself. During the investigation of roots or traces it performs a double operation: it pulls down the essence of the genre and rebuilds it in a different manner. This dislocation is the 'de-construction' that forms the core of the problem and does not even try to search for a way out from it. The privative prefix indicates that it is not a new construction that is emerging from the existing one but the slipping of the meaning and absolute presence of the previous system. Parallel with this, absence, the lack of embodiment of that which previously existed, is pushing itself into the spotlight. One can say from this point of view that deconstruction on the one hand is buried inside itself, and on the other, it is extremely decadent. It is not suited to anything else but criticising against already-made objects, so it is far away from fertility, from any kind of productivity of novelty, unless the process is not directed towards creating absences which define the new in terms of the old. It was able to rethink the tradition of western philosophy and history so was able to do with any structure built on it: it transformed these systems by dislocating hierarchy and binary contradictions and twisting causality.

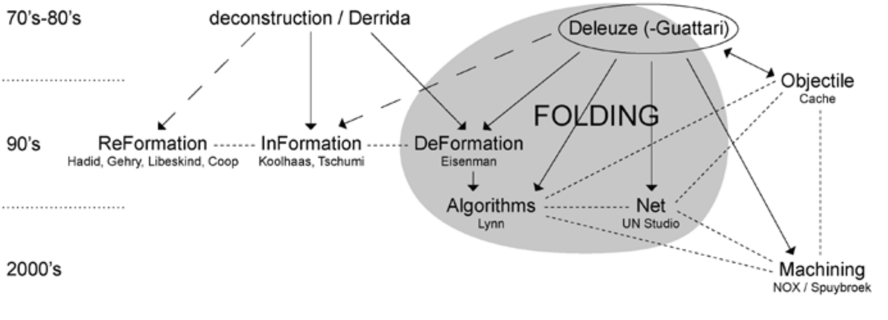
It is not our task in this paper to describe the transposition of deconstruction from philosophy to architecture or architecture theory. Simplifying the process it can be stated that if philosophy, constructed mainly from the notions of building, can be deconstructed, then this would lead to a reaction on the original construction: architecture. Deconstruction as a manner in architecture (and in art[9]) led to a criticism of modernity that was new and totally different from the former theories. It was abstract and semi-dependent on context at the same time, it was able to reconsider the modern tradition and to immerse itself in centuries of art history[10]. Deconstructing architecture does not necessarily or primarily mean building but the reviewing of the role, the meaning and the relationships of the principle and of the architect.

This kind of thinking dared to face up to the heterogeneity and pluralism of the era, as well as to the instability or uncertainty that was promised without any doubt by the present. This courage and honesty labelled deconstruction as negative. The inconvenience (the indefinite perception) that went together with focusing on the metropolis and chaos became terrifying, especially when the buildings became reality. That means it is not necessary, for the sake of simplifying, to consider the phenomenon as denial or negativism: it is the distorting mirror of the eighties from France to the United States. It is just an embarrassing self-reflection of the world that has fallen apart, that has lost its centre, that is without 'grand narration': it is the adequate manifestation of the era and it cannot offer a way out or an alternative. This kind of postmodernity, the decades beyond 'rationality', including architectural postmodernism, is not easily understood: it has overstepped the boundaries of comprehensibility. Look at the insanity and chaos of William Burroughs: his 'cutting-up' and 'folding-in' techniques made a new complexity from the pieces of the already written texts. In the age of 'postmemory'[11] when there is no personal experience, no real but manipulated traces from the past, architecture is also manipulating these layers of history by transforming them from the condition of latency to 'presence', by building a heterogeneous and layered system of different pasts. These pasts are distorted and deformed to be given new meanings in other times, in a new context.

Now we can see clearly that abstracting always needs a previously constructed system. Thus deconstruction 'always posits an orthodoxy which it »subverts«, a norm which it breaks, an assumption and ideology which it undermines', said Charles Jencks in 1988. 'And the minute it loses this critical role, or becomes a dominant power itself (as in so many academies), it becomes a tyrannical bore. The same is true of Deconstructionist architecture: it works best as an exception within a strongly defined norm.[12]' According to my understanding, which has not much in common with Jencks' postmodern reprimand, a 'strongly defined norm' does not exist anymore: today's aesthetic experience is not normative. It cannot be deduced from reality without the complete and complex relationships of that. There are traces and impressions in the present everywhere, therefore architecture made by deconstructive methods tries to accommodate the topographical, morphological, historical, cultural contexts. It wants to dissolve in this continuous heterogeneity while taking progression into consideration. Asking those questions that Derrida or Peter Eisenman proposed helps us to find our role and meaning in the posthumanic chaos, to have our 'exactly-the-same' forms in the multiplicity of the eighties. But Jencks is right if we are looking on deconstruction as an apparent paradox, since both the existing structure ('pretext') and the operating system ('language') is chosen and built up by the author ('writer-architect'). That is to say the creating process involuntarily becomes arbitrary and individualist. It is obvious that the influence of this author is unavoidable, because an 'analogue response' always has to be a personal reading of the story. The paradox is that architectural deconstruction uses the Barthesian principles in order to liberate the oeuvre from the architect while it is making the most individualist ‘symbolism’: the author is not dead and abstraction is deformed. Finally the pieces of the fallen-apart world are set up in an exact, moreover an ideological construction.

**DeFormating Decon**

If we consider ‘deconstructivism’ as a label stuck on an almost heterogeneous group of independent architects, the boring image would be expressed with great subtlety. In this way architectural theory got to the centre of interest, above all since Derridaian thoughts was transposed into architecture through this principle. The main characters of this transposition were Bernard Tschumi and Peter Eisenman and the importance of studying their activities – notably around 1990 – would seem to be self-evident. Now we have to focus on Eisenman because he integrated another ‘conceptual tool’, again based upon philosophy, to his experiments and we want to seek for new forms[13]. Transposing folding to architecture appeared to be useful and relevant as a way of solving the cultural-aesthetic problems sketched out earlier in this essay. Of course as with deconstruction it was not just Eisenman who was interested in the topic, and this tendency was made public and canonized by the Architectural Design special issue *Folding in Architecture*[14] edited by Greg Lynn[15] in 1993. If possible, this classification was more diverse than the deconstructive label, Lynn rather presented attempts of interpretations than offered a definite reading of Deleuze. Looked at today, the importance and the level of the writings and projects is very unequal: now only two of the eleven plans seem to be important, not including Eisenman’s.[16] Such variety appeared in the scale of the projects since, according to Lynn, folding wanted to be suitable for furniture designs and regional structural plans. Although it wasn’t known where the movement would head for, emphasizing the items in the book gives the precise framework of the ‘after-decon era’ with images influenced above all by Eisenman and Libeskind: the five emphasized texts have now gained a wider importance than they had at the time.
Deleuze’s original extract[17] was the (philosophical) base and placing it there linked the whole oeuvre of the French thinker to the realm of architecture. This text was used in John Rajchman’s



analysis that would be developed further in other books by him[18] giving a specific interpretation of the theory, establishing the transposition of it and emphasising on the architectural movement. Peter Eisenman was represented by three 'authentic' folded projects, one of them was the Rebstockpark-plan in Frankfurt, which was supported by the critically acclaimed text, *Folding in Time: The Singularity of Rebstock*. The also many times, and in many places cited summary of editor Lynn[19] posits the works in a context that extends from deconstruction to intricate systems with the later increasing an emphasis on mathematic and biological references.
The fifth highlighted article was written by Jeffrey Kipnis whose out of date title *Towards a New Architecture* enveloped a great 'medical report' about architecture in the early nineties considering especially the legacy of decon. According to him two ways appeared to be feasible to get out of the exhausted collage system. One direction, so-called InFormation, that is based on collecting a graft, 'usually by encasing disparate formal and programmatic elements within a neutral, modernist monolith. The resultant incongruous, residual spaces are then activated with visual layering, programmatic innovation, technological effects and events.'[20] This classification can be understood easily by looking at the purely modernist figures of the buildings of Rem Koolhaas[21] and Tschumi from the nineties that are transfer the essence of architecture from form (aesthetics) to event. Kipnis's other proposal, DeFormation is about 'grafting abstract topologies [into the program and space] that cannot be decomposed into simple, planar components nor analysed by the received language of architectural formalism.'[22] This way, the direction Eisenman follows, tries to step forward to never-seen complex forms from deconstructive fragments hence it has to refuse the tool of superposition and develop program and figure together. (To be precise and consistent I need to introduce a third group of architects like Zaha Hadid and Frank O. Gehry who continued their quite simple formal experiments. For want of a better term, I call this marking-time ReFormation that is about fulfilling and exhausting the analogue design with digital constructing devices in order to achieve a realization.[23])
We have to continue with investigating DeFormation further, not just searching for the new form but rather to 'think architecture beyond complementarity and binarization, beyond subjectivity and signification'[24] as Elizabeth Grosz posed the question comparing the philosophical work and the architectural use of Derrida and Deleuze. Such questioning is significant especially because these kinds of battles were fought earlier in non-representative or non-objective arts. The expression in French informel art analyzed by Deleuze (and its American counterpart, action painting, by Rosalind Krauss[25]) rivalled abstract constructions as 'hard edged' collage-movements for finding a new role for the author, trying to answer the problem of form-giving and processing, and even getting rid of restrictive tradition while resisting capitalism and consumerism. Francis Bacon was one of the few artist whose paintings were neither representative/objective nor abstract. This singularity was underlined by Deleuze[26]: the blurred and distorted, familiar and yet at the same time strange bodies were floating in a recipient space. Such unlimited, contourless 'figurativeness' has indefinite flesh, no skeleton, it is dissolving as much in the inner space of the painting as outside of the frame, while the body still has an immanence. Folding in architecture attempted to behave in just this way.

**Deleuze-4-ever**

'As is always the case in architectural design theory, DeFormation is an artifact, a construction of principles that have emerged after the fact from projects by diverse architects that were originally forged with different intentions and under different terms and conditions.'[27] Contrary to the architectural deconstruction that was canonized after taking shape slowly and 'just at the moment when literary intellectuals are jumping off… the Deconstructivist bandwagon'[28], architectural folding emerged in the same year as the English translation of Deleuze's Folding-book, therefore it did not have a long history. Conversely it is true that the oeuvre of Deleuze is coherent and extensive from the seventies and 'le pli' appeared much earlier at least in Leibniz's work[29]. All the reasons and processes mentioned above contributed to see the universe folded from folds: unifying all the systems, creating new memory-politics, mediatising societies, formal questions directed at smoothening, ending 'post-everything'. Considering time as a moment dependent on chance introduces the events to 'weak aesthetic experience'[30]. 'Architecture can no longer be bound by the static conditions of space and place, here and there. In a mediated world, there are no longer places in the sense that we used to know them. Architecture must now deal with the problem of the event.'[31]

Now we need to see what the intentions, purposes and means of folding were around 1993: how did the theory and design process try to exceed or smoothen decon? Architectural event can be a keyword as it was with InFormation but here event wants to be integrated into the structure, it is not satisfied with residual spaces. Decon let the event happen by confronting human movement with disjunctive space, within a static collage, folding made it happen as it permitted structure to be influenced by event. This sort of event is heterogeneous and it contains chaos in contrast to decon that was facing up to chaos. The former was then 'dissolving' the latter was a kind of 'resistance'. In decon, interstitial meant the existence of something in between worlds, shifted into flowing worlds, into the fluidity of interstitial, into 'milieu' as Deleuze called. More than anything else, the notion of rhizome explains this complexity, to see the world as a non-hierarchical, net-like multiplicity. Rhizome is the milieus that contain each other mutually, and it is not a copy, rather it is a kind of map, a universal metaphor. In its background, as we will see it later[32], there is philosophy, literature, neurology, biology.

While Derrida was originally investigating only the closely related realms of knowledge that are philosophy, literature and language, Deleuze was truly interdisciplinary as expanding his theory or letting it be influenced by art (Baroque, Bacon, cinema[33]) and science. As re-evaluating the oeuvre of Freud, deconstruction was itself one of the indicators, Deleuze exchanged the Derridaian psychoanalysis to a 'schizoanalysis' that could better describe and understand the condition of our schizoid era[34]. Besides these Deleuze merged architectural references and spatial relevance into his theory contrary to the nonspecific deconstructive thoughts. The early research of Bernard Cache and their teacher-student relationship helped to expound on the theory of the frames and images that define 'interstitiality'.[35]

Mark Wigley was accompanying decon along its history in architecture[36] so as Rajchman was doing with folding. Hence in 1993 Rajchman just wrote an introduction, waiting for the results of being transposed from philosophy. They did not overrate the historical relationships of each

movement: in the case of deconstruction universality of modernism and constructivism was considered as the base of the critiques both theoretically and formally, while on the other hand, Baroque was the first era that tried to be 'not divided up by sets of discrete elements'[37], to find the world continuous. This is one of the reasons why decon was constructed from discrete elements into a unity by superposition, and why folding was a process with continuous operations into a diversity by superimposition as Eisenman called it. After 1990 it was necessary to get over the fact that we had been dissecting the classical old problems of modernity before. This kind of critique needed to be exceeded because universality and homogeneity did not mean a perspective anymore, and neither did the collaged, built-up-from-pieces heterogeneity. The previously mentioned graft could have been an alternative technique to superposition: it creates heterogeneity while it makes efforts to cooperate with and keep together the parts instead of emphasizing incoherence and contradiction. It wanted to result in the complexity of Deleuze which of course differs from the notion of Venturi's postmodern[38]. As we saw in the paintings of Bacon folded systems and forms are blurred into a seamed whole, rather than edged seamlessly as in decon: the former hides all initial elements, the latter leaves them intact in the collage. In the same way that the pictures did not want to become representative or personal, folded architecture tried to escape from expressionism by the means of the so-called 'informelity'[39], contrary to decon's investigated personal formality. The eighties' simultaneity of figure and ground[40] created a smoothened into a rhizomatic, continuous space without inside and outside (Vidler referred to it as 'death of object') but with an integrated 'interstitiality'. Thus it is obvious that as decon's heterogeneity stressed morphology folding's homogeneity preferred topology, the act of movement or material heterogeneity rather than the heap of ruins or formal rupture.
Decon was born in a Cartesian world: its thinking and form was based on the modern tradition of Euclidean geometry that appeared in the limited and rigid structure of a grid that is constructed from points. The fluid notion of folding is embodied in a geometry that tried to move away from Euclid, tried to be 'anexact' or so-called 'pliable' and its assumed shape is an infinite surface from folds. Therefore the space of folding is curved or curvilinear in contrast to decon, which is angular and rectilinear. If the latter was atectonic in the meaning of dislocating the traditional elements of buildings like columns or walls, then the former should be 'hypertectonic': it superseded the historical structural-tectonic systems, it wants to be independent from gravity and the duality of vertical and horizontal but it still needs to be constructed in a kind of regular way.

**Non-folded architecture**

Michael Speaks in the foreword of *Earth Moves* asks whether the shift from 'deconstructivist' forms to folded forms should have been qualified as new.[41] It is obviously an important problem but it cannot be the main issue if we are focusing on the relationship between architectural theory, cultural history, and the history of media and information technology. Mario Carpo has this focus when he writes about that it was partially a fortunate coincidence of the intention of folding to smoothen the fragmented and rigorous forms of decon and the rapid spread of computers, and what is more, he affirmed, the process was fertilized by the continuity-theory of

Deleuze. But the declared ‘folding movement’ in architecture did not become readily established thanks to another coincidence of paradigmatic and historic facts[42].

As I have mentioned, in 1989 the Promised Land of liberal democracy penetrated nearly the whole world but it was not calculated at that time that a kind of balance, in other words a cold war, guaranteed the holding back of capitalism/globalism. After a few years it realized that without alternatives or even utopias there is nothing more than global capitalism gone out of control repressing cultures and local identities[43]. Changes were quite fast in the historical-political-economical scene, and architecture kept pace: the prompt killing of decon was succeded by the quick demise of folding in a five years period. The later death was also quickened by the essence of the movement itself, inasmuch as it was still a very conceptual idea. In the years that followed ‘simple chaos’ and elitism, after the postmodern state and philosophy itself, including deconstruction in this way, there was nothing in the background: the system had come to an end. Such single abstract or conceptual issues like folding were not able to survive those changes or the absence of ‘grand paradigms/narratives’, or rather the slippery plurality.

Practical-technical problems also emerged as for example in the case of Lynn’s Presbyterian Church building in New York, the so-called ‘deconstructed blob’, that has not much in common with the original idea after its completion in 1999. It underpins Kipnis’ contrast between the much higher rate of realization for InFormation and the hypothetical attribute of DeFormation[44]. Because of this theoretical character the multiplicity of folding gives another apprehension whether there is no technique to include all the complexities in the world to a certain ‘project’. Though Lynn and others tried to link principles like René Thom’s chaos-theory or the results of biological researches into their systems, complexity would not be under their control: it is much more ‘perplicated’ but to understand it[45].

**BAD diagrams**

Now, if we see the universe as continuous, and also acknowledge that designing methods have gained extreme significance, it is obvious to consider architectural theory over at least the last few decades as the history of the diagram. Then the phenomenon of diagram is more than pure geometry, research, illustration, structure, or the superposition of these – but rather the totality and essence of all. It is a medium, a device between anteriority, interiority and exteriority (using Eisenman’s notions): diagram is a mirror that shows, but not represents, the process of design. In this way it could be a kind of theoretical tool but exactly the shift from ‘pure forming’ to the entire ‘economy of architectural production’ makes it an all-encompassing medium. As it is a tie it helps theory to get closer to practice, to unify author and work or even to link any discipline into design. Folding is a kind of diagram and it has a key position in the diagram’s system as it widened the realm at the same time as tightening the link between the elements of the realm. All the above-mentioned architects, artists and theorists created their own notion of the diagram, differing from each other in only minor ways. Foucault, Bacon, Deleuze, Eisenman, Lynn, and UN Studio have an interpretation of this designing manner and although it would be necessary we cannot go into them in this paper.

Folding did not fully replace decon but enlarged it, literally smoothened the method and made it more sensitive to contexts. As the neutral museum or the white cube lost their significance with the exodus of art from them, giving importance to the city, nature and event, architecture also refused to correspond to a surface-like context and it focused on the event. Thus folding transformed both figure and ground, making a shift towards non-analogue thinking. The traditional analytical-critical device nearly turned into a generative one, concerning both the design process and the author. Conventional contexts started loosing their dominating, repressing position in the architectural creation but not by erasing themselves nor by the postmodern 'genius loci' growing rich in meaning. There were other, latent, contexts that came in, in fact all contexts tried to come in that resulted in the built environment becoming just one input data of diagram. So the folding technique was considered as semi-digital if architecture, architect and building became a part of the network-system and the input data did not remain a single parameter. The latter means that the parameters, all changing quantities are unfolded into discrete numerals of the diagram that creates a complexity.[46]

However it entails a critique since this model turned into the manifest of global capitalism instead of criticizing it. From this position two questions emerge for BAD diagrams: do we accept the network-system and analyse it to see where to head for and reach, or turn against it to resist? It is a very important issue if we cite again a distinction between decon and folding: decon tried to manage a kind of autonomy of the whole architectural paradigm, whether in a declared way or not, but folding wanted to assimilate. Both happen with buildings among contexts (as built and latent environments), architecture among disciplines (beyond interdisciplinarity), architect among experts (observers and designers of structures). I have to emphasize the significance of Marc Augé's *Non-lieus*[47] sans identity and Derrida's *Mal d'archive*[48] sans memory, with no comment. Rather I cite the text which this essay began: 'Illusion implies a process, and that this process is oriented to a certain end. In this sense, the project of Enlightenment, the basis of modernity, still participates in a secular theism, in the idea that it is possible to discover an absolute reality, within which art, science, and social and political practice can be constructed on the basis of universal rationality. When this system enters into crisis (and it does enter into crisis, precisely as a result of the impossibility of establishing a universal system), we find ourselves faced with the *real* crisis of the modern project and the perplexing – we might say critical – situation of our contemporaneity.'[49]

## Notes

1 An attribute of Deleuze, 'a folding through or folding across', see Rajchman, *Constructions*, 18.

2 Cf, Elizabeth Grosz's statement about the resistance of 'applying' Deleuze's work into any discipline: 'theory is not so much to be applied as to be used'. Grosz, 60.

3 Solà-Morales, 60.

4 This kind of liberation made two parts of the world, but those parts were not similar to the previous parts existed before 1990. The so-called developed, highly industrialized or just developing countries are getting over postmodernism, while the rest of the world, stepping forward from third position to the second, remains on the periphery in the condition of a premodern state. To clearly understand this problem of 'internal duality' see for example the artworks of William Kentridge.

5 This notion of Francis Fukuyama's (*The End of History and the Last Man*. London: Penguin Books, 1992) means that liberal democracy has conquered the world, beaten monarchy, fascism, communism and homogenized (or it is homogenizing) all systems. Therefore it is the endpoint of governing and the ideological development of men. Cf. with its critique of Derrida (*Specters of Marx*, New York & London: Routledge, 1994).

6 Kipnis, *AD 102*, 42.

7 Kipnis, *AD 102*, 42.

8 Mario Carpo: Architecture in the age of pliancy. In: Architecture d'Aujourd'hui 349, Nov-Dec. 2003, 102. Carpo cited Wolfgang Köhler, a psychologist and his 1929 experiment that examined angular and round shapes, associated with created arbitrary names: 'taketian' and 'malumian'.

9 The *Omnibus Volume*, the cataloguing of 'deconstructive movement' studied the paradigm's philosophical and architectural references, the relationship with Russian constructivism, and dealt with such artworks as those of Anselm Kiefer, Valerio Adami or Gordon-Matta Clark. But it has to be noted that adapting deconstruction to art is not a declared act and an underpinned fact.

10 Contrary to this, postmodernism rejected modernism and abstraction while it was reconsidering tradition loudly. The situation, of course, was not that black and white since the main architectural theorists of the decade (Colin Rowe, Christopher Alexander, Christian Norberg-Schulz, Aldo Rossi) have a plurality in thinking and they had a great influence on certain directions of architectural deconstruction.

11 Marianne Hirsch: *Family Frames. Photography Narrative and Postmemory*. Cambridge: Harvard University Press, 1997.

12 Charles Jencks: Deconstruction: The Pleasures of Absence, in: *Omnibus Volume*, 120.

13 Tschumi was building the La Villette Park in Paris at the time and published his early writings and a brand-new book on 'urban events' partly following his previous researches: *Architecture and Disjunction: Collected Essays 1975-1990*. Cambridge: MIT Press, 1994 and *Event-Cities series vol.1*, Cambridge: MIT Press, 1994.

14 As the paper was published by Academy Editions, London and the editor is Andreas Papadakis again, the comparison with the deconstructive debut in 1988 goes without saying.

15 This publication with editing the issue was the coming-out of Lynn as well. He graduated from Miami University of Ohio in 1986 and he got an M.ARch. from Princeton in 1988. In 1992 he published 'Multiplicitous and In-organic Bodies' in *Assemblage 19*, later republished in *Folds, Bodies & Blobs* and he was a co-editor of *The Fetish*, Princeton Architectural Press (with Edward Mitchell and Sarah Whiting).

16 These are Lynn's *Stranded Sears Tower* and Reiser+Umemoto's *Croton Aquaduct* (under the name of 'RAA Um' including Stan Allen). It also has to be mentioned that both Jesse Reiser and Nanako Umemoto studied at Eisenman's Cooper Union and Institute for Urban Studies in New York. Polarizing and simplifying: amongst others, furniture plans and a 'usual-project' appeared from Frank Gehry. One project was shown from Thomas Leeser who had just left Eisenman's office after several years working with him. Two buildings were presented and talked much about in the critical writings by Bahram Shirdel who studied at Cranbrook Academy of Art under Daniel Libeskind (as Reiser+Umemoto), taught two years at Harvard with Eisenman and Kipnis, then at AA with Kipnis, then disappeared in Iran. Henry Cobb's ordinary tower was the only built project. Chuck Hoberman is rather a sculptor and a toy-developer. Stephen Perella was not yet able to come out with a significant achievement (see: Hypersurface Architecture. Architectural Design 68, ed: Stephen Perrella, 1998).

17 *The Fold – Leibniz and the Baroque: The Pleats of the Matter,* 16-21.

18 *Constructions and The Deleuze Connections* (Cambridge, Ms: MIT Press, 2000).

19 *Architectural Curvilinearity: The Folded, The Pliant and the Supple*, also published in Fold, Bodies & Blobs.

20 Kipnis, *AD 102,* 43.

21 The OMA/Koolhaas also uses a kind of folding that has significance in relieving hierarchy and making the space fluid. The plans of Jussieu Library, are a case in point, with its continuously sloping slabs and the spatial complexity that it results. At the same time it should be noted that this simplifying intention leads to the aesthetic degrading, to using up folding. Another connection between Koolhaas and Deleuze is the interpretation of Foucault's panopticon (see the project of Arnhem Prison).

22 Kipnis, *AD 102*, 43.

23 Cf, Hani Rashid: Morphing the Sublime. In: *Metamorph 9. International Architecture Exhibition*. Focus Fondazione La Biennale di Venezia, 2004.

24 Grosz, 59.

25 See her books: *The Originality of the Avant-Garde and Other Modernist Myths* (Cambridge, Ms: MIT Press, 1985) and *The Optical Unconscious* (Cambridge, Ms: MIT Press, 1993) and compare for example the abstract expressionism of Jackson Pollock and the intuitive experiments of Coop Himmelb(l)au. It also has to be mentioned that Krauss positioned Eisenman's work in this context ('Death of a Hermeneutic Phantom: Materialization of the Sign in the Work of Peter Eisenman' In Peter Eisenman's *Houses of Cards,* New York: Oxford University Press, 1987, 166-184), as she integrated Derrida's grammatology-theory with her critical practice to attack the autonomy of art.

26 *Francis Bacon: Logique de la Sensation*. Paris: La Différence, 1981. See also Rajchman's interpretation in the chapter '*Abstraction*' in his *Constructions*.

27 Kipnis, *AD 102,* 44.

28 David Lodge: A Review of the Tate Gallery Symposium in *Omnibus*, 90.

29 The notion of 'le pli' appeared first at Deleuze in his book of Foucault (Paris: Minuit, 1986, and Minneapolis: University of Minnesota Press, 1986).

30 Solà-Morales regarded the pli-theory (from the French *Foucault*-book of Deleuze) as one of the significant pillars of 'weak architecture' as a penetrating program to understand reality of today (the cited essay was written in 1987 but published in English in only 1996).

31 Peter Eisenman: Unfolding Events: Frankfurt Rebstockpark and the Possibility of a New Urbanism (1991). In: *Written into the Void*, 13.

32 Dozens of notions of Deleuze will be used in architecture in the nineties for example as a designing tool (Eisenman's mapping) or formal-structural relevance (Lynn's biological figures).

33 *Cinema 1. The Movement-Image* (Minneapolis: University of Minnesota Press, 1986. trans. Hugh Tomlinson, Barbara Habbersam) and *Cinema 2. The Time-image*. (University of Minnnesota Press, 1989. trans. Hugh Tomlinson, Roberta Galeta).

34 See the two-volume *Capitalisme et Schizophrénie* of Gilles Deleuze and Félix Guattari: *L'Anti-Œdipe* (Paris: Minuit, 1973) and *Mille Plateaux* (Paris: Minuit, 1980).

35 Cache sees architecture as the 'art of the frame' connecting furniture with the outer world: this kind of folding was written down in his *Terre Meuble* around 1983 and cited by Deleuze in 1988. So it was part of the AD-issue but in a latent manner and of course after the breakthrough of the movement it was immediately published in English, further reinforcing the architectural relevance of it. It was the first item of ANY's *Writing Architecture* series that underlies its significance. Here we cannot dwell on the theme 'objectile' of Cache and Deleuze although it is an important base of non-standard theory.

36 From the MOMA-show to the *The Architecture of Deconstruction: Derrida's Haunt.* Cambridge, Ms: MIT Press, 1997.

37 Rajchman, *AD 102*, 60.

38 See the different historical analyses of postmodernism and folded complexity at Lynn (AD 102, 8), Rajchman (*Constructions*, 17), Jencks (*Post-Modernism and the Revenge of the Book*, 189).

39 See Anthony Vidler's excellent comparison of the 'biotechnological informe' of Lynn and Tschumi's informe based on Bataille (Vidler, 227).

40 Cf, the oeuvre of Eisenman.

41 *Earth Moves*, xiv-xv.

42 Cf, new prefaces by Carpo in the reprint of AD 102 1993 (London: Wiley and Sons, 2004) and symposium *Twelve Years of Folding - Deleuze and the IT-Revolution in Architecture* (21 May 2005, MAK, Wien) with the declared purpose to investigate the hegemony of the mathematics of calculus in the technological environment of the time and the first formal avatars of the digital revolution in architectural design with eg. Stan Allen, Carpo, Eisenman and Lynn.

43 Mark C. Taylor: *The Moment of Complexity. Emerging Network Culture.* Chicago: The University of Chicago Press, 2001.

44 Kipnis, *AD 102*, 48.

45 Cf, main critiques of UN Studio's work.

46 This idea has not much in common with the theory of Kas Oosterhuis and Marcus Novak whose premise says let technology (actually digital or nano) into architecture.

47 Marc Augé: Non-places. *Introduction to an Anthropology of Supermodernity.* Transl: John Howe, London – New York: Verso, 1995.

48 Jacques Derrida: *Archive fever. A Freudian Impression.* Transl: Eric Prenowitz, Chicago: The University of Chicago Press, 1995.

49 Solà-Morales, 59.

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# Towards an Understanding of the Analogical and Digital interface in Architecture by Means of Communication and Cultural Theory

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# Towards an Understanding of the Analogical and Digital interface in Architecture by Means of Communication and Cultural Theory

**Abstract**

In Siegfried Giedion's last text entitled, *Architecture and the Phenomena of Transition*, he traces the evolution of Western architectural space-conceptions from Antiquity to Modernity. In turn, Gideon's work influenced the cultural theorist Marshal McLuhan (McLuhan 1962, 44), who developed a media-structuralist account of the Western evolution of space-conceptions but, in terms of media effects on human senses, sensibility and consciousness.

McLuhan referred to the pre-Socratic perception of space as 'acoustic space', which engages perception synesthetically (a ratio of all the senses in interplay) at a human scale; i.e. as an embodied consciousness. However, since Antiquity, a Western space-conception evolved which he describes as 'visual space'; the result of the abstraction of the eye from synesthesia or the dominance of the eye over the other senses. This sensibility, or spatial bias, was conditioned by the evolution of the phonetic alphabet environment (a medium that extends the eye) which fostered a progressively analytical mechanical worldview in the West. However, during the 19th century, with the invention of electric communications (a medium that extends the nervous system) and, eventually with the emergence of wired connectivity and information technology, McLuhan again characterised our post-modern space-conception as 'neo-acoustic'; i.e. a digitally amplified space and concomitantly extended perception characterized as virtual synesthesia. Post-Modern neo-acoustic space is a side-effect of the electronic extension of our nervous system and brain which constitutes the environmental surround facilitating human communication within the 'Global Village'. Today, we more and more live in a networked world (wired and wireless) sustaining individual and collective consciousness by means of disembodied images, or virtual simulacra; that is, a social reality in which consciousness is constituted of sensory images generated in real-time communication of information processing and programming.

In particular, McLuhan's media studies enhance one's awareness of the cultural formation of spatial biases conditioned by technological environments. During our pre-alphabet (acoustic space) and phonetic alphabet (visual space) traditions, these respective cultures fostered conceptions of architectural space and form grounded in physical or analogue extensions of the human body. With the emergence of an electronic neo-acoustic space, or cyberspace, whereby synaesthesia is mediated digitally at the scale of a global surround, our body image, or

identity tends towards the discorporeal. We are living between dual or hybrid influences of embodied and discarnate acoustic spaces, which foster new conceptions and approaches in architectural design. Architectural conceptions of visual space, acoustic space and neo-acoustic or cyberspace will be explored in this paper.

**Introduction: Technology and Cultural Space**

The work of Marshal McLuhan provides both an in-depth and comprehensive discussion of the origins and evolution of space conceptions which are of great interest to architects for understanding the conditions shaping architectural form. McLuhan provides a communication theory of cultural transformation, or the evolution of cultural forms, which naturally includes architecture. The following quote from his book, entitled *Laws of Media*, best introduces the co-formal relationship between spatial sensibility, media and cultural formations:

*Visual space, as distinct from acoustic space, is an artifact, a side-effect of using a phonetic alphabet. The alphabet acts to intensify the operation of vision and to suppress the operation of the other senses…….The transformation to visual space from acoustic space occurred in ancient Greece. What took several thousand years to complete has taken us several decades to reverse: the West now bathes in the emotions of post literacy.*
(McLuhan 1988, 4)

In several of his books, McLuhan offers variations on this theme where he equates the historic period, since the invention of writing, with that of civilization because the eye progressively displaced the ear in terms of being the dominant sensory modality. This altered ratio-of-the-senses first emerged in ancient Greece whereby the eye was abstracted from the interplay with the other senses, due to the highly abstract quality of phonetic literacy, so that "the line became the organizing principle of life" (McLuhan 1967, 44-45) This eye bias fostered man's abstract rational ability, a hallmark of Western sensibilities, in which space, time and consequently form was conceived of as linear, continuous and connected. Since Greek and particularly Roman Antiquity, this homogeneous and static visual space was manifest by means of, for example in architecture, the growing use of analytic geometries and axial organizations, of perpendicular or mutually orthogonal lines and symmetry, which were by-products of an emerging rationalist sensibility. (McLuhan 1968b, 7) In this regard, Siegfried Giedion defines the origins of architecture in terms of the formal conceptions that manifest the mutual perpendicular relationship between a vertical axis and horizontal plane, such as the Ancient Egyptian pyramid and obelisk.

A key concept in McLuhan's work is that any technology or medium is an extension or amplification of human senses, faculties or organs and when given material embodiment tends to create a new environment. McLuhan stresses that a new environment alters our sensory threshold (ratio-of-the-senses) and this in turn changes our outlook and expectations. The automobile extends the foot and requires the support of steel, oil, rubber, highway and other infrastructural services which are synonymous with environmental effects. Similarly, there were infrastructural environments or worlds of, at first, the alphabet and writing and later the printing press that, respectively, extended the eye; one side-effect of these environmental effects was the subliminal influence of 'visual space' as rationalized intuition. Today, we live in an information environment sustained by an electronic infrastructure, as an extension of the human brain and nervous system, with the significant side-effect in which acoustic space is perceived in terms of the Global Village. Just as the preliterate world lived in an acoustic space of the physical or analogue village, today in the post-literate age we live in the neo-acoustic space of a virtual village sustained by means of instantaneous processing of digital information at a global scale. McLuhan described the information age as follows:

*Since electric man lives in a world of simultaneous information, he finds himself increasingly excluded from his traditional (visual) world, in which space and reason seem to be uniform, connected and stable. Instead Western….man now finds himself habitually relating to information structures that are simultaneous, discontinuous and dynamic. Hearing, as such, is a form of all directions at once, a 360 degree sphere, so that 'knowing' itself has been recast or retrieved in acoustic form…*
( McLuhan 1988, 102).

An important idea for understanding the interface between the analogical and digital worlds is that all media and technologies are human extensions. Today our spatial bias is informed by the effects of instantaneous electronic communication, i.e. neo-acoustic space which is characterized by being spherical, resonant and non-linear or de-centred. This in turn fosters an awareness in which the planet is experienced or 'known' as a simultaneous interplay of events (the Global Village). Information structures (wired and wireless connectivity) facilitating instantaneous flows of information feedback, feed-forward and manipulated by software programming transcribes the images we produce of ourselves, individually and collectively, from physical or analogue beings into virtually images of digitized discarnate being; i.e. in terms of Baudrillard's work this is the media grammar of simulacra as the manifestation of the extension of our nervous system. The oral space of pre-literate cultures is sustained by speech exemplifying the natural human scale of acoustic space within the social group (i.e. tribal) as a traditional village. This traditional village and the current manifestation of 'neo-acoustic space' as a 'global village' bracket the Western tradition of a 'visual space' conception and its concomitant architectural and urban forms.

### The Western Modern Paradigm and Visual Space

Ancient Greece, from the 8th century BCE and until the time of Pericles (4th century BCE), when the use of the phonetic script was primarily considered in terms of a craft, was essentially an oral and therefore tribal culture. Greece, however, did become increasingly literate, but the acceleration of the visual gradient begins in Ancient Rome. Here the visual bias was evident in the prejudice for linear organization and contained space, as for example, within the military and civil bureaucratization of the Roman Empire in terms of spatial organization and control. The fact

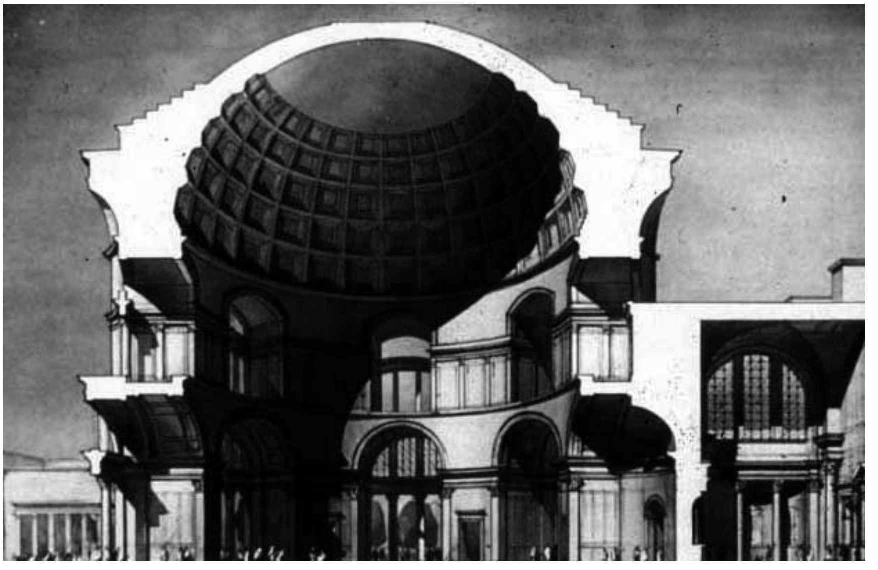

**Figure 1**
Baths of Caracalla
Section showing large windows defining 'inside' from 'outside'

that 'all roads led to Rome' represents the center-margin linear organization which exemplifies an abstract ability, or rational sensibility, that could manage a city and Empire perceived as a homogeneous contained space. With regard to architecture, the Pantheon best exemplifies the emergence of this visual space conception whereby, the architectural historian Siegfried Giedion wrote that, "from then on, all concepts of architectural space would almost invariably be synonymous with the concept of a hollowed out interior." (Giedion 1971, 86) Giedion also claims that the Pantheon and the Roman baths (figure 1) are ancient forms that first manifest the dichotomy, or rationalization of a homogeneous continuous space, as a distinct inside versus outside space; for example, with the first appearance of large wall openings or windows in the Roman baths as opposed to the predominantly courtyard form, or 'inner' space of traditional buildings operationally defines this dichotomy.

Giedion's observations concur with McLuhan's idea that an intuition or sensibility for visual space, as a homogeneous static container, in-formed the development of Western spatial and formal conceptions.  Giedion also mentions that the concept of a wide paved street was also invented in Rome. In Ancient Greece streets were narrow and irregular except for stately approaches to public places. For example, in the Roman town of Timgad (in present day Algeria) the Roman predisposition for uncompromising axial alignment (a side-effect of the alphabet) is well expressed in the Cardo and Decumanus, the two most important streets that cross each other at right angles in the center of Roman towns, slicing the body of the city into four quadrants. The forum, or that 'contained' homogeneous space, as a stage for public interactions, could be found at their intersection. (Giedion 1971, 75).

With the fall of the Roman Empire, which the Canadian Economic Historian Harold Innis believed was due to a shortfall of papyrus from Egypt in the 5th century CE due to rising Egyptian Nationalism, the loss of phonetic literacy was replaced by other means. That is, the Cathedral became the 'text' for a Feudal non-literate age. The implication is that this age veered from the evolving Western visual gradient and recovers some of the preliterate audile-tactile sensibilities associated with more plastic and sculptural forms of communication, as opposed to the more abstract geometric and linear forms of ancient classical architecture (e.g. barrel vaults versus ribbed vaults). The West begins to recover the trace of the visual gradient during the Renaissance as Lewis Mumford acknowledged in his text entitled *Sticks and Stones*:

*Victor Hugo said in Notre Dame that the printing press destroyed architecture, which had hitherto been a stored record of mankind. The real misdemeanor of the printing press, however, is not that it took literary values away from architecture, but that it caused architecture to derive its values from literature. With the renaissance the great modern distinction between the literate and illiterate extends even to building; the master mason who knew his workmen and his tools and the tradition of his art gave way to the architect who knew his Palladio and his Vitruvius.* (Mumford 1955, 6)

That architecture would, at the beginning of the Modern period "derive its values from literature" is to say that it effectively subscribes to those sensibilities, or spatial and formal prejudices, induced by visual space. The reference above, to Palladio and Vitruvius, indicates a return to a literate world in which the printed texts displaced the cathedrals as modalities of knowledge and con-texts (i.e. dominant media as messages in-forming human sensibilities). However, Mumford critiques the content or figure of the book whereas McLuhan's analysis of the text's effect on architecture is the study of the ground of printing as it alters sense and sensibility which, in turn, informs spatial and formal concepts manifest as architectural events (i.e. the medium is the message). Therefore, for McLuhan, the printing press was a unique phenomenon in its time because it manufactured the first mass produced commodity which was unprecedented; the uniform reproduction of the same text based on repeatable type. The translation of writing into a uniform mass produced commodity requires a process of translation by fragmentation and sequential alignment; the means by which an organic process, i.e. hand writing, is transformed into printed text by a mechanical process (i.e. fragmentation and linear sequence) or machine. The mechanization of writing, which was a handicraft, was the prototype for the mechanical translation of all handicrafts and faculties which foreshadows the birth of the scientific revolution (17th century) and the worldview of a Newtonian clockwork universe ('reason' as a linear logical process) and the Industrial Revolution (18th century) or the factory system as assembly-line of standardized uniform manufacturing. In this regard the architectural critic, Chris Abel, writes:

*In The Myth of the Metaphor, Colin Murray Turbayne recounts how early machine technology affected scientists' and philosophers' perceptions alike of both the natural and human world. To Rene Descartes (1596-1650) and Isaac Newton (1642-1727), upon whose work the science of the First Machine Age was constructed, the universe did not simply work like a machine it was a machine, of which gravitational pull and the movement of the planets were amongst the most predictable features.*
(Abel 2004, 61)

As mentioned above McLuhan stresses that a new media environment alters our sensory threshold and this in turn changes our outlook and expectations. With a significant change in culture, or paradigm shift due to infrastructural development, human perception and expectations are fundamentally altered. In this paper the shift from the modern industrial worldview towards the views, or consciousness, of the emerging postmodern electronic culture will be elaborated upon by means of architectural examples that reveal concomitant developments in conceptions of space and time. The concepts of absolute space and time, and gravitational pull, were implicit to the phonetic-mechanical cultural ground that conceived of the clockwork universe. This conception presumed that space was a void; a neutral container or reified vacuum in which space and its contents were objects. The example of vanishing point perspective and the Cartesian grid exemplify this neutrality and the absolute mathematical quality of a space in which there exists no co-creative co-formative interaction between a user and building or between the observer and the observed; such as in the space of vanishing point perspective.

**Towards a Postmodern Paradigm and Acoustic Space**

With the introduction of the telegraph in the 1830's a new paradigm began to appear on the cultural horizon. And by the early 20th century an emergent electronic culture was beginning to significantly deconstruct the visual bias of absolute space and time. The concept of relativity in physics and what the architectural historians Slutzky and Rowe refer to as transparency in architecture and art began to inform the aesthetic sensibilities of the post-industrial paradigm. (Rowe 1997). The experience of 'relativity' and 'transparency' refer to the phenomena of a space-time continuum in which the user/observer interprets or participates in the meaningful production of space and form. For example, cubism and collage displaced vanishing point perspective and the Cartesian container, or what F.L. Wright criticized as the neutral 'box' in architecture, in terms of a new and more dynamic aesthetic of space. Rather than providing a single vanishing point view of an object on a canvas surface, a cubist painting provides multiple vanishing point perspectives, on a single surface, in the manner of collage. Whereas, vanishing point perspective is a rigorous linear mathematical construct that sustains the dichotomy between the observer and the observed (as a picture produced by a camera lens) cubism is constructed by a juxtaposition of views of multiple vanishing points. (Giedion 1967, 436-437) Therefore, the cubist fragments are ordered in terms of the interval or gaps among the views, which the viewer configures and reconfigures by means of scanning the surface in time; i.e. a change in sensibility exemplified by a shift in space conceptions from absolute space and time to relative space-time. This paradigm shift from industrial to post-industrial cultures involves a significant change both in terms of aesthetics as from visual space to an acoustic space sensibility and the transformation of the user or viewer of an artifact, from spectator to participant or interpreter.

In this regard McLuhan also argues, “It was visual space in its aspect as container that was reflected in thinking of an ‘inside’ or ‘outside’ world.” (McLuhan 1988, 59) By contrast, McLuhan states, “With the return of [neo-]acoustic space through the ground of electric technology, the visual forms of detachment and separation of inside and outside were dissolved” (McLuhan 1988, 59) and, transparency or space-time in architecture exemplifies this dissolution. Slutzky and Rowe elaborate upon both a literal and phenomenological transparency. The latter represents the effect of juxtaposed surfaces with various degrees of physical transparency in Modern architecture, whereby material transparency facilitates viewing multiple perspectives while moving through a building. Hence, what Siegfried Giedeon referred to as a ‘layering of planes’, (Giedion 1967, 434-443) or a collage of degrees of transparent surfaces, Slutzky and Rowe refer to as literal transparency which they claim was the definitive aesthetic of Modern architecture. An ‘prototypical example would be Mies van de Rohe’s Barcelona Pavilion, 1928-9.

By contrast, phenomenological transparency also engages the user in an interpretive or psychological as well as a sensorial construction of the space. However, this aesthetic of the built-work is in-formed by cultural expectations, or perceptual prejudices (i.e. ‘inner’ perspectives), which constitute a subliminal cultural intersubjective bias. Phenomenological transparency bypasses visual space and also the residue of visual space intrinsic to literal transparency (i.e. of an ‘inside’ and ‘outside’ world associated with the perspectival quality of each of the multiple perspectival views) for the construction of a meaningful representation of the ‘inner life’ of the user or for what Heidegger means by ‘dwelling’. Acoustic space as a resonate field or collage of juxtaposed surfaces (literal transparency), or as an architectural conception of the ‘inner’ space or life-world of the user (phenomenological transparency) represents the deconstruction of visual space in the early 20th century due to the paradigm shift from industrial to post-industrial cultures and this will be elaborated upon in what follows.

The cultural bias for acoustic space expressed in architectural and urban conceptions is evident in the work of Frank Lloyd Wright. Chris Able in an essay entitled, Prime Objects, (Abel 1997, 182-183) which provides a short history of the evolution of the high-rise in the 20th century, contrasts Wright’s Larkin building with the Bradbury building in Los Angeles (figure 2); both were designed around the first modern atrium spaces. The latter expresses a visual bias in terms of a clear distinction between inside and outside spaces, whereby the offices are contained as boxed-in rooms around an enclosed atrium which functions solely to provide circulation by means of mezzanines, elevators and stairs. This building conception embodies the industrial or mechanical worldview designed as fragmented Functionalist form accommodating specialized needs within contained or visual spaces.

In the Larkin building the spatial qualities are distinctly different. The atrium acts as a communal arena whereby individuals engage with each other over time to spatial transparency which, for the user, constitutes a multi-perspectival environment. This building is also a model or simulation, as the architectural historian William Curtis states, of a street in the Industrial city of Chicago. (Curtis 1996, 126-127) That is, the Larkin atrium (figure 3) is bracketed by a pair of Chicago high-rise facades, as open skeletal frameworks, and lit from above by a grid of skylights. Wright created a world of work in which there is a sense of community in a space resonating with an industrial culture of common values and common sense i.e. the emerging 20th century bias for literal transparency.

By contrast, Wright's Johnson Wax building (figure 4) provides a dramatic alternative of phenomenological transparency. Although this building appears to be a boxed-in, or a contained visual space, with its absence of windows and a glass ceiling providing artificial illumination from above, in effect, it epitomizes the attempt by Wright to create a paradigm of the world of work. That is, as a community of shared sense and sensibilities, but without reference to an outer space such as the streets of Chicago. This lack of symbolic reference to an outer space induces the users to rely on their own 'inner' resources, of values, intentions and expectations (as a kind of kinship group), to generate a meaningful space of work. Also, the plasticity of the room with its curved surfaces and the sculptural qualities of the mushroom or lily-pad columns, under the rather dramatic lighting, fosters a sense of space as a stage for work as a co-performative event. Therefore, in contrast with the Larkin building's linear formal organization the sculptural and plastic dimensions of the Johnson Wax building evoke a sense of tactility, which is more involving aesthetically than visual transparency. In this way, the Johnson Wax building exemplifies an architectural concept not of visual but of phenomenological transparency, or a neo-acoustic space representing the lifeworld of a culture. This building as a microcosm of culture, and viewed in terms of McLuhan's work, expresses an increasing gradient of acoustic sensibilities because, unlike the Larkin Building, it is less a product of the mechanical age and more a consequence of its own period of electronic communications; i.e. the radio age.

Another interesting example of Wrights work is his design for the community of Broadacre; (figure 5) an urban plan which also represents the paradigm shift between Industrial and the emergent electric cultures. The railway epitomizes the urban form of the center-margin industrialized metropolis. However, in Broadacre, Wright excludes the railway and explicitly designs in terms of infrastructures based upon the automobile, telephone and electricity which foster a decentered environmental form (Curtis 1996, 316). In this regard, Broadacre can be perceived as a collage in the manner of a decentered, discontinuous distribution of functions, or a field of interplay among diverse activities, which exemplifies acoustic space as opposed to the visual form of the railway metropolis. It is interesting to note that driving a car engages one aesthetically in the event of cubist or literal space-time. Driving requires not just looking out of the front windshield but necessitates integrating multiple views provided by the rear-view mirror, side-mirrors, side views as well as front views in an ongoing dynamic integration of multiple perspectives.

**Figure 2**
Bradbury Building, Los Angeles
View of atrium

**Figure 3**
Larkin Building
View of the Atrium.

**Figure 4**
Johnson Wax Building
Interior view.

**Figure 5**
F. L. Wright: Usonian vision of Broadacre

Hence, Broadacre incorporates the emerging sensibility, conditioned by the automobile culture as a tacit or subliminal influence, but expressed as a new conception of an emerging individual and cultural consciousness by means of Wrights design for Broadacre.

**Postmodernism and Neo-Acoustic Space**

In the next phase of Western cultural development, with the emergence of electronic and digital technologies, we see the intensification of a feature of the new neo-acoustic sensibility; i.e. regarding the recovery of group or collective behavior in terms of ecological responsibility in the postmodern tribal age. The move towards a more explicitly tribal or feudal society is exemplified in both analogue and digital terms. The latter is expressed by means of discarnate being in the cyberspace of the global village, while the former is represented, for example, in the next generation of atrium office buildings exemplifying emergent corporate or kinship values. As mentioned above, atriums have evolved as small-scale urban spaces that are a microcosm or paradigm of the indigenous culture. Today, the culture is increasingly shifting from industrial values of detachment and fragmentation and individualist orientation towards an attitude embracing inclusive and responsive sensibilities regarding the physical and cultural contexts. There is now emerging an ecological sensibility for green sustainable architecture and also for a deeper ecology which incorporates a more metaphysical concern for social and psychological sustainability. This deep ecology is a concept emerging within the conditioning framework of the cyberspacial infrastructure of instant communications because increasingly, privacy is eroded due to the simultaneity and instantaneity of information retrieval and distribution in the global village.

In this context, Abel and McLuhan recognize what is essentially at stake in the global village. That is, an environment sustained by instant connectivity and digital technologies such as computers, television (meaning far-seeing) and the telephone (meaning far-hearing) ‘transcribes’ the physical or analogue body into ‘virtual’ visual and acoustic images in cyberspace. This happens in order to facilitate movement at the speed-of-light, which in a virtual global village of instantaneous communications fosters the recovery of feudal/tribal social patterns. The message of instant communication media therefore, is not what is said or written, but the fact that the sender and receiver are sent, as virtual images in respective technological sensory modalities, so that they can commune in cyberspace. Abel, in his text entitled Cyberspace in Mind, quotes from the work of the author Michael Heim who wrote, “At the computer interface, the spirit migrates from the body to a world of total representation. Information and images float through the platonic mind without grounding in bodily experience. You can lose your humanity at the throw of the dice.” (Abel 2004, 6-47) McLuhan refers to an emerging identity crisis which results when the physical or analogue body and world are obsolesced by the cybernetic environment (McLuhan 1998, 67). Consequently, the challenge for architecture is to reconcile our analogical and digital experiences by means of hybridizing the superhuman discarnate experience with the increasingly deconstructed human scale by means of a deep ecology or sense of embodied dwelling. In this regard Abel writes:

*What actually happens when anyone uses the net…… is that we 'inhabit' cyberspace pretty much as we 'inhabit' any physical realm, by metaphorical extension of ourselves. We assimilate the 'non-spatial' realm of cyberspace into a spatial world we already know. In doing so we humanize what might otherwise appear a lot stranger than it already is. That may also be an illusion, but it is one that confirms and enhances – not threatens – our special way of being.*
(Abel 2004, 57)

Above, in Wright's work, we saw acoustic space represented in terms of spatial and formal conceptions influenced by a dominantly electric environment in the expressions of Broadacre and the Johnson Wax building. In a recent issue of the Economist, there is a supplement entitled A Special Report on Mobility, with a particular emphasis on the changing architecture in a currently emerging nomadic society sustained by an environment of wireless connectivity and mobile digital technologies.  The article notes that architects such as William Mitchell at MIT (author of e-topia) claim that the biggest change in architecture today is with respect to the fact that "20th century architecture was about specialized structures-offices for working, cafeterias for eating-and that people are no longer tied to specific places." Mitchell claims that there is "a huge drop in demand for traditional, private, enclosed space". (Kluth 2008, 8) In this regard this article argues that Frank Gehry's design for the Stata Centre in MIT (figure 6) provides an 'inner' space or cultural milieu for an emerging nomadic society, grounded fundamentally upon wireless connectivity with minimum hardware requirements (e.g. iphone or Blackberry or laptop) so that direct Wi-Fi access to internet is provided by this architecture as digital 'oasis'. The oasis is a flexible ad-hoc interactive forum characterized as a complex dynamic space of multi-functional human associations; i.e. a layering of social, psychological as well as material needs, which is referred to as a new kind of "hybrid space" which in this building is a "student street" described as:

*…an interior passage that twists and meanders through the complex and is open to the public 24 hours a day. It is dotted with nooks and crannies. Cafes and lounges are interspersed with work desks and white boards, and there is free Wi-Fi everywhere. Students, teachers and visitors are cramming for exams, flirting, napping, instant-messaging, reading and discussing. No part of the student street is physically specialized for any of these activities. Instead, every bit of it can instantaneously become the venue for a seminar, a snack or romance.*
(Kluth 2008, 8)

The end of the Western architectural paradigm, exemplified by visual space, is now being displaced by a neo-acoustic resonant space of diverse simultaneous human associations and constantly in flux, in the manner of phenomenological transparency. This now involves the interplay of sustainable requirements that are sociological, psychological, and ecological as well as the traditional functionalist requirements for physiological comfort and shelter, a prime feature of Functionalist Modern architecture. If the defining aesthetic of Modern architecture, according to Giedion, was a cubist 'layering of planes', or the literal transparency of physical acoustic space, then might not the defining aesthetic of a postmodern architecture in the digital neo-acoustic

**Figure 6**
Stata Building, MIT
Interior view.

**Figure 7**
Commerzebank, Frankfurt
View of one the skycourts.

**Figure 8**
National Commercial Bank, Jeddah
View of Perched courtyard.

age be a conception incorporating a 'layering of sustainabilities', which are sociological, psychological, and ecological. Hence, today the built-work as analogical form would be informed or shaped by, and in sympathy with, the sensibilities for a deep ecology (i.e. layering of sustainabilities) in the digital environment. This reconciliation is evident, for example in Foster's Commerzbank in Frankfurt, Germany. (figure 7)

As an atrium building this work responds to the cultural needs of the contemporary society by providing this 'layering of sustainabilities'. Digital technologies were used in the design, construction and now the maintenance of its building systems, but the interesting feature is that it is responsive to its cultural and physical context for socializing the space by the use of passive energy systems as well as multiple-level garden courtyards. These courtyards humanize the scale of the building while providing 'user friendly' spaces. In this way, the building's multi-layered responsiveness makes this a responsible building design, and this ethical approach, or ecology of mind, is an essential qualifying feature of the emerging sensibility of the global village. That is, by maintaining an ethical stance we maintain a connection, as McLuhan claims, with natural law, which is derived from the existential conditions of the analogical or physical body and the natural world. As mentioned above, in cyberspace the body and the world are discarnate, and consequently, the ground for ethical behavior is dissolved creating the postmodern anxieties inherent to this identity crisis; a crisis due to the difficulty of reconciling the natural/analogue and the discarnate/digital states of being and worldviews.

**Conclusion: Responsive/Responsible Design**

An important approach towards realizing this necessary reconciliation is in terms of responsible design which integrates a 'layering of sustainabilities' with sensitivity to local conditions in the global village. It is interesting to note that Foster adapted the skycourts in his building from a design of the National Commercial Bank (figure 8) in Jeddah, Saudi Arabia. (Abel 1997, 85-86) There, the architect Gordon Bunshaft adapted the middle-eastern concept for the courtyard house, the vernacular of this desert environment which is an effective passive energy space as well as a social space for the family or kinship group. Foster's use of this form reveals a significant aspect of the dynamics of the information age. That is, in the Modern period architectural influences radiated from the West in the manner of a centre-margin organization. In the postmodern age, information is networked and knowledge is distributed instantaneously in the resonant space of the global village. Therefore, in Bunshaft's work, the vernacular informed a global architecture which in this way represents the reconciliation of the analogue/local with the digital/global worlds of architectural awareness. That is, a responsible design would achieve a reconciliation that attunes human sensibility to the fact that we must live both locally and globally. That is in a 'glocalized' space architectural conceptions incorporate both corporeal and discarnate images of us and the world by means of a 'layering of sustainabilities' and understood in terms of both analogue and digital human identities. This implies understanding technologies in terms of a pragmatic aesthetic ability; i.e. applying an architectural imagination, or a phenomenological rather than an abstract analytic, for perceiving the scale and pace of our lives imposed by relatively distinct technological environments (acoustic and neo-acoustic space) for the purpose of maintaining a sustainable balance of material, social and psychological needs. Ironically, the effective use of the instantaneous and global retrieval of knowledge and information by digital technologies is an important means of in-forming this phenomenological attitude, in the aid of conceptualizing architectural form with regard to the necessary reconciliation of our digital and analogical bodies as well as worldviews.

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FIG 1: Section, Baths of Caracalla. intranet.arc.miami.edu

FIG 2: Bradbury building. davemblog.blogspot.com

FIG 3: The Larkin Building of 1903. solohq.solopassion.com

FIG 4: Johnson Wax Building. homepages.ihug.co.nz

FIG 5: Broadacre, Wright, Frank Lloyd. www.dkolb.org

FIG 6: Gehry's Stata Center at M.I.T. www.nytimes.com

FIG 7: nature in buildings | commerzbank ... web.mit.edu

FIG 8: The National Commercial Bank, www.pritzkerprize.com

Lerner

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# Tools for the Virtual: Atmosphere and Bodily Presence of Digital Space

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# Tools for the Virtual: Atmosphere and Bodily Presence of Digital Space

### The emergence of the radical new

Architecture of the digital space is increasingly evolving towards the imaginary, atmospheric, and invisible sphere beyond the reality of built space. The virtual world of digital technologies has changed the practice of the design process by blurring the boundaries between fictitious and real space. Experimental conditions of layering, folding, and programmed randomness of algorithms via the means of combined software enable the visual representation of architectural hybrids. This new reality of the design process is envisioned as renderings, virtual 3d building models, diagrammatic projections, and animated movies. Yet, how can the innovation of the digital turn in the design process effect, shape and interact with our perception and experience of space? Are the digital and the analogue world fundamentally different as their means and techniques may suggest?

Reformulating the discipline and redefining its role and functions, architects have applied theories of chaos and complex systems, and experimented with non-linear and topological geometries. Another major influence in the past decade or so has been the philosophy of Gilles Deleuze whose concepts of lines of flight and segmentarity, fold and rhizome, diagram and abstract machine, smooth space, and the event are settled as a whole in a vagueness and indiscernibility where "events, or processes which, however temporarily, share a common milieu."[1] They create a field of emergence where the radical new being can unfold in a pre-conditional state. In *A Thousand Plateaus* Deleuze names this "plane of immanence of radical experience" as the 'virtual' that refers by definition to something non-representational and a-signifying.[2] What will be unfolded presents itself in a plane of continually shifting interconnections, intensities, forces, flows, events and spaces. This elaborate and complex concept of the virtual does not proclaim "preformed spaces, objects, or functions but… pure potentials or virtualities, morphic resonances as variable densities of space-time, activity, or action."[3]

Deleuze rejects representations of the world that are either correct or incorrect, and instead proposes theories that function as *abstract machines* in the process of architectural design, because "the abstract of diagrammatic machine does not function in order to present something, even something real, but rather constructs a real to come, a new type of reality."[4] For him, creative evolution is not the movement from the *possible* to the *real*, because the process of realization would offer nothing new and would not bring more reality and difference to come into existence. Since the possible is just like the real with the only difference that it does not exist this movement would not be creative but rather means that other possibilities would not be realized.

Within Deleuze's undestanding, the *virtual* becoming *actual* is the true creative evolution, because the actual does not bear a resemblance to the virtual that it embodies. Hence, while the realization of the *possible* is characterized by likeness, preformation, and restriction, the actualization of the *virtual* makes the radical new emerge, the unfolding and revealing of unpredictable differentiation.

By using the Deleuzian concept of the virtual, the present essay aims at tracing the intervention between the digital and the analogue architecture and how their tools of potentials for the radical new are carried out to affect our experience of space.

**The virtual as motion**

In the mid-nineties, many avant-garde architects turned towards a Deleuzean understanding of the virtual in order to expand on a merely technical understanding of virtual reality. Deleuze's philosophy also offered a possibility of moving beyond the semiotic underpinnings of deconstructivist architecture and its obsession with (the impossibilities of) signification. Initially, the Deleuzean becoming was translated rather directly as motion by such theoretically oriented architects, such as Greg Lynn and Marcos Novak.

Following the Deleuzean theory of 'space-time' Greg Lynn abandons the architectural "ethics of stasis" of an idealized fixed-pointed space of Cartesian coordinates by defining an object as "a vector whose trajectory is relative to other objects, forces, fields and flows… and motion. This shift from a passive space of static coordinates to an active space of interactions implies a move from autonomous purity to contextual specificity."[5] An example of Lynn's concept of "animate form" is offered by his design for the Hydrogen House in Vienna. Its form reflects the dynamics of the contextual forces as a movement in time. Via an animated sequence Lynn shows the process of a preliminary triangular volume gradually becoming transformed by solar rays and the shadows cast onto the form proceeding from east to west. In order to define a real, buildable project, however, Lynn stops this process of metamorphosis at a specific, arbitrary moment and selects a static image as the final design. As critics, such as Jeff Kipnis, pointed out, this means that the element of motion is no longer present in the actual architectural form. Instead, Lynn's animate form spatializes time. They bring to mind the sculptures of Umberto Boccioni presenting a static, rather than animate, representation the dynamic forces of movement.

A more Deleuzean understanding of the radical becoming has been proposed by Marcos Novak whose interactive four-dimensional architectural spaces can be traversed in virtual reality. Here, the virtual is not petrified into a representation, but the price to pay is that the architecture must remain within virtual reality. Following Bergson's speculations about the sense of vision being responsible for the thing ontology that makes it so difficult to understand radical becoming, Novak has also attempted to negotiate representationalism by escaping the visual. In his installation, *invisible architecture*, at the Venice Biennale 2000, Novak presented an animated video displacing liquid forms in a four-dimensional space, but the main element was a bar equipped with sensors that indicate five invisible sculptures. When the viewers moved their hands close to the sensors, they could trigger interactive sounds that reveal the shape and position of the invisible objects. In this way, Novak's project of invisible architecture, unlike Lynn's concept of animate form, does not freeze motion and thus may more accurately capture the essence of the actualization of the virtual in the sense of Deleuze.

This danger of petrification of the virtual through representation was also addressed by theorist Brian Massumi who reintroduces questions of perception, bodily experience, and a transformative effect of architecture by shifting the point of view from the physical properties to the performance and lived-in processes of the built space. Though the virtual cannot be seen or even felt, "in addition to residue in static form, the formative process leaves traces still bearing the sign of its transitional nature."[6] Instead of focusing on the design process he gives attention to the afterlife or architecture, its interference with the users that may implicate the potential for further change. Similarly, this idea of the new realities resonates with Rem Koolhaas' theory of "Bigness" that links unprecedented size, rather than unpredictable geometries, to the creation of "programmatic alchemy," maximum possibility, intensity, freedom, and entirely new social interaction.[7]

**Shape as diagram**

Besides architecture that attempts to capture the virtual by focusing on motion, there is another reading of an a-signifying virtuality that has been suggested by the proponents of "projective practice." The central concept is shape, a condition which will bring forward alternative realities, enable new social events, and the potential for change in architecture. In "Notes around the Doppler Effect and other Moods of Modernism" Robert Somol and Sarah Whiting outline the new conditions of shape in architectural practice by presenting, though arguing against "the oppositional strategy of critical dialectics," the binary model of *form* versus *shape, criticality* versus *projection, representation* versus *performativity, index* and *diagram, autonomy* and *instrumentality, hot* and *cool media, dialectic* versus *atmosphere*.[8] Introducing a scientific metaphor that is perceivable and measurable such as the Doppler Effect in architecture is supposed to explain the effects of the virtual, its multiple contingencies and overlaps with politics, economics and theory, although the analogy in architecture remains vague and indistinct which terms precisely should be related to each other.

They refer to Marshall McLuhan's distinction between "hot" and "cool" media in order to demonstrate the different effects of the performance on the user. In contrast to hot media such as film, radio, or the photograph, which are well filled with data, and hence "high-definition," cool media like television, the telephone, or a cartoon provide only a small amount of precise information so that much has to be filled in by the audience. For McLuhan, "hot media are, therefore, low in participation," while "cool media are high in participation or completion by the audience."[9] But his concept of participation merely functions on a cerebral level without including the active interference and bodily participation of the beholder. If the medium is the message, as McLuhan claims, the form may be less important than the tools that create them. New instruments shape new environments by transforming our view and experience of the world.

Furthermore, the promoters of shape construct a contrast between Peter Eisenman's highly articulate forms, and Rem Koolhaas' diagrammatic and non-specific shape projects. *Shape* is interpreted as situational and contingent, in contrast to the essential, abstract, and immaterial realm of *form*. In Eisenman's indexical reading of the frame structure of Le Corbusier's Maison Dom-ino the substantial architectural parts are not reduced to mere geometry of the structural requirements. It serves as a self-referential *sign*, which Eisenman defines as the "minimal conditions for any architecture."[10] Hence, he interprets the specific location of the columns as a deliberate configuration that intentionally reinforces the particular geometric relationship between the two different sides of the rectangular plan. By contrast, in Koolhaas' diagrammatic reading the frame structure, namely the steel skeleton of the typical Manhattan skyscraper, is the most potential architectural *diagram* for instigating unprecedented events and behaviors. Projecting a multiplicity of virtual worlds on a single metropolitan site, the diagrammatic section of a skyscraper such as the Downtown Athletic Club becomes an instrument of the spatial discontinuity for producing new events. Hence, "the diagram is a tool of the virtual to the same degree that the index is the trace of the real."[11]

**The effect of presence**

However, to a much greater extent than adopting McLuhan's theory on media, the concept of shape draws on Fried's essay "Art and Objecthood" in 1967, which is a polemical description of minimal art that he calls literal art.[12] In his opinion, "*art degenerates as it approaches the condition of theatre*."[13] Shape in minimal art decisively depends on the effect of presence, because it implies both a specific environment and the beholder moving in it. Hence, it is *incurably theatrical*, the shape objects are seen as actors on a stage deriving meaning from their singular effectiveness as mise-en-scène. When one perceives the shape object in its spatial context, in the expanded field of the architectural conditions, it significantly promotes an awareness of the physical presence, and thereby "theatricalized the [viewer's] body, put it endlessly on stage."[14] This effect of *theatricality* is subversive, defiant, and to his mind, fundamentally inimical to the essence of sculpture.[15]

Referring to "the effect of presence" and theatricality that Fried has defined as an essential characteristic of shape in literal or minimalist sculpture, shape in architecture, according to Somol, operates by the performative properties of spatial immediacy and presence. He lists twelve attributes of shape as *illicit, easy, expandable, graphic, adaptable, fit, empty, arbitrary, intensive, buoyant, projective,* and *cool*.[16] Shape operates with the *seduction of contour,* with the *calculated vagueness* of the surface area that sometimes rely on the presence and mere size of large-scale buildings. For Somol, the work of Rem Koolhaas and OMA, such as "the twisted knot" of the Central Chinese TV building, operates with "the graphic immediacy of logos, generating a new identity" and thus seems to exemplify the specific qualities and potential of shape.[17] CCTV is a kind of cornered loop created by six approximately rectangular elements but with a deviation of a few grades. Its two main towers are interconnected at their basis by a common platform and joined at the top via a cantilevered L-shaped overhang. Somol characteries the

CCTV building as a "minimalist frame for a monumental void," alluding to his definition of shape as "a hole in a thing it is not" – which is of course a paraphrase of Carl Andre's famous definition: "a thing is a hole in a thing it is not." Like a distorted rhomboid that is hollowed out at its core, they appear like a residue, a "leftover packing material for an object that has been removed." Beside CCTV, other projects of OMA, such as the NeWhitney, the Seaterminal Zeebrugge, or the Dutch Embassy also use this strategy of a "cake-tin architecture" for accommodating all programmatic elements within a single shape. It represents a new species of an "exceptionally perceptive and adaptive organism."

Though Fried saw it as a negative impact on art, most artists in the '60s and early '70s thematized the involvement of the viewer in installation art and happenings, and considered it a positive and very creative possibility. Similarly, some architects, such as those of Archigram, proposed visions of indeterminacy and "emergent situations" arising from unplanned encounters. The environment is without any fixed spatial configuration and ideal form but rather emphasizes individuality of action and space. According to Peter Cook, "The 'building' is reduced to the role of carcass - or less," a concept that is close to Koolhaas' idea of a "cake-tin architecture."[18] The new social event is then the immediate experience initiated by architecture, the revolutionary event, such as the '68 student revolting.[19] They involve a *psychogeography* of space, though most of these projects are fictive, unbuilt and probably unbuildable. To imagine the unfeasible, the deliberate impossible in architecture, similar to Vladimir Tatlin's monument to the Third International, implies that these ideas are less grounded in reality than in utopian visions closer to *nothing is impossible* in constructive and social terms.

Using utopian ideas as a metaphor for liberty and new social configurations, architects presented experimental projects of non-plan, moveable environments, infinite megastructures, and floating entities. What is vital and more important than a technologically advanced structure is the experience supplied by a "responsive" environment. Conceiving "fit environments for human activities," Reyner Banham contrasts the *controlled* environment where one has a limited range of environmental choices with the *controllable* or *responsive* environment that provides the more fully background conditions for what he describes as an "interdeterminate open ended situation."[20] In the sixties, advances in plastic technology produced pneumatic constructions that could be inflated in a very short time, making inflatables a symbol of the responsive environment freed from the constraints that previously bounded architecture. Pneumatic technology does not reduce architecture to traditional aspects of space or construction that can be seen as its essence, but rather opens up new subjects. Banham's plastic dome, Michael Webb's Cushicle and Archigram's Environmental Bubble represent *une architecture autre*, a term that Banham derives from the French art critic Michel Tapié's *un art autre*, who connects this term to raw, seemingly unfinished, anti-formal experiences.[21]

**Atmosphere, mood, and immersion**

Likewise, Sylvia Lavin argues against the essence of things like plastic material that goes across the borders of art forms. In contrast to Fried's modernist position to reduce art to its very essence, the plastic lacks essential characteristics that could be assigned. In contrast to the modernist materials such as glass, steel, concrete or stone, plastic seems to be an artificial material without a nature. As a synthetic liquid material that is now after a molding process in a stable state, the jointless surface of plastic does not only allow a differentiation of material densities ranging from solid, translucent, to almost invisible. Plastic material is now virtually everywhere in everyday life, with a pervasive use within the human body. This condition resonates with Koolhaas' assumption that "the cosmetic is the new cosmic..."[22]

For Lavin, the deployment of plastic entails the techniques of *plasticity.* The new forms relate to the inventiveness made possible by new material conditions and material techniques. Additionally, plasticity has given way to new structures and experimental conditions, and a new "density of experience."[23] Projects such as Elisabeth Diller and Ricardo Scofidio's Blur Building operate with the plasticity of a solidifying atmosphere that provides the visitors' sight with changing opacity. Constructed for the Swiss Expo 2002 at the base of Lake Neuchatel the media pavilion was essentially an artificial cloud hovering above the water. This formless, surfaceless, unpredictable fog mass producing long trails in winds is made of filtered lake water shot as fine mist through 31500 pulsing water nozzles that via computers adjust the force of the spray due to shifting conditions of temperature, humidity, and wind speed. Drawing on water in various forms, ranging from fog, mist, dew to a broad selection of bottled drinking waters from around the globe, it seems that the Blur Building uses water as primary substance of its architecture. Yet, the 300 feet wide by 200 feet deep platform consists of a tensegrity system that cantilevers from piles in the water over the lake surface. When the visitors approach via a 400-feet long ramp at the central open-air platform, they enter a dimensionless inhabitable medium that seems not to be bound to the gravity of buildings but is rather created by a complex interference between manmade forces and natural environment. According to Diller, the Blur pavilion is conceived to present an *anti-spectacle* as a reaction to the insatiable hunger for visual stimulation by displaying the complementary visual effect of "low definition," an optical "white-out" of erased visual references with only obfuscating images.[24] Yet, seen from the shore the artificial fog form, as Diller admits, presents a visual icon, while from within and an event architecture promoting bodily presence via blurry vision and "blushing brain coats" (smart raincoats) indicating the affinity between visitors by changing colors.

The idea of a fog building that abandons the conventional concept of space stems from the Japanese artist Fujiko Nakaya who created the first "fog sculptures" in the late '60s. She envelopes people and constructive elements in a fog environment, transforming them into impalpable beings of fog stripped off their materiality. At the Osaka Expo in 1970 Nakaya covered the entire Pepsi Pavilion project by the New York based group Experiments in Art and Technology (E.A.T.) organized by Billy Klüver with artificially generating water fog.[25] According to the ideals of E.A.T., the artist makes active use of the inventiveness and proficiency of the engineer, such as the adoption of the existing technology of fog simulation, and thus seeks to bring the artistic medium more in touch with new materials and technological transformations. As Klüver states, the theatrical, interactive environment of the installation, with its 210 degree spherical mirror, fog atmosphere, a programmable surround-sound system, and kinetic sculptures called “floats” should encourage, instead of a fixed narrative of events, live-programming that involves an experience of choice, freedom, and participation. The pavilion is one of the first projects of an *immersive space* that predates the virtual reality that engages the viewer through electronic and digital media. By extending and transforming the physical space, it gave the individuals the liberty of shaping their own reality and sequence of events.

Both Diller and Scofidio’s Blur building and E.A.T.’s Pepsi pavilion rely on a kind of physiological architecture and its synaesthetic immersions such as sound, visual effects, humidity within an artificial environment. They project active, sensitive territories, involving, in the process of perception, multiple modes of awareness of the senses, in the retina, by breathing, the enforcement of orientation, views, ambiance, aura. These psychogeographical aspects of the material yet invisible, elusive, microscopic dimensions of space conceptually address the mood, atmosphere, and conscious invention of a new reality and a new event structure of architecture.

Though the digital and the analogue world, or the virtual and the physical reality, seem to suggest contrasting different concepts of space, one can doubt the multiplicity of different spaces. Digital images, animated movies and Novak’s concept of invisible architecture of virtuality, likewise, involve atmospheric immersion and affective intensity. Maybe one of the most vital aspects of digital innovation and change is the interference between architecture and the user. Virtual space, too, engages an intertwinement with the space of bodily presence, it can be experienced as sphere that creates in the viewer emotional response. For there is no concept of spatiality without presence of the body, or, as Adolf Hildebrand suggested in 1893, the individual objects exist not as something within external boundaries but rather as parts internally animated by their “own capacity to evoke and stimulate our idea of space.”[26]

## Notes

1 Elisabeth Grosz, “Architecture from the Outside,” in Cynthia Davidson, ed., Anyplace. New York: Any Corporation, 1995, p. 21.

2 Gilles Deleuze, Félix Guattari, *A Thousand Plateaus*. Minneapolis: University of Minnesota Press, 1987, p. 63.

3 Sanford Kwinter, “The Reinvention of Geometry,” in *arch+* 117. 1993, p. 83.

4 Gilles Deleuze, *Bergsonism*. New York: Zone Books, 1988, p. 142.

5 Greg Lynn, “An Advanced Form of Movement,” in *Architectural Design* 67. 1997/5+6, pp. 54-56.

6 Brian Massumi, “Sensing the Virtual, Building the Insensible,” in *Architectural Design*, vol. 5/6, no. 68: Hypersurface Architecture, p. 20.

7 Rem Koolhaas, “Bigness, or the Problem of Large,” in Rem Koolhaas, Bruce Mau, *S, M, L, XL*. New York: Monacelli Press, 1995, pp. 506f.

8 Robert E. Somol, Sarah Whiting, “Notes around the Doppler Effect and other Moods of Modernism,” *Perspecta* 33, pp. 74f.

9 Marshall McLuhan, *Understanding Media, The Extensions of Man,* London: ARK, 1987, p. 39.

10 Peter Eisenman, “Aspects of Modernism: Maison Dom-ino and the Self-Referential Sign,” in K. Michael Hays, ed., *Oppositions Reader*, New York: Princeton Architectural Press, 1998, p. 191.

11 Robert E. Somol, Sarah Whiting, “Notes around the Doppler Effect and other Moods of Modernism,” *Perspecta* 33, pp. 74f.

12 Michael Fried, “Art and Objecthood”, in: *Artforum*, vol. 5, no. 10 (June 1967), reprinted in: Gregory Battcock, ed., *Minimal Art: A Critical Anthology,* New York: E.P. Dutton, 1968, pp. 116-47.

13 Michael Fried, “Art and Objecthood,” p. 20.

14 Michael Fried, “Form as Shape”, in: *Art and Objecthood, Essays and Reviews*, Chicago, London: University of Chicago Press, 1998, p. 42.

15 Paraphrasing Michael Fried’s notion of the *objecthood* of minimal art, Pier Vittorio Aureli claims that architecture by Koolhaas, Herzog & de Meuron, Diller + Scofidio, or MVRDV is merely concerned with its *contenthood*. For Aureli, “the superficiality of Shape is nothing but the solidification of excess content, metaphors, meanings, and symbols without sense... Shapes can be interpreted as hieroglyphics; incomprehensible, yet their stubbornly figurative and symbolic character wants to be deciphered.” Pier Vittorio Aureli, “Architecture and Content: Who’s Afraid of the Form-Object?,” in *Log*, Fall 2004, pp. 29f.

16 Robert Somol, “12 Reasons to Get Back into Shape,” in Rem Koolhaas, AMOMA et al., *Content.* Köln: Taschen, 2004, pp. 86f-87.

17 Robert Somol, “12 Reasons to Get Back into Shape,” in Rem Koolhaas, AMOMA et al., *Content*. Köln: Taschen, 2004, pp. 86f-87.

18 Peter Cook, “Control and Choice,” reprinted in Peter Cook, ed., *Archigram,* London: Studio Vista, 1972, p. 68.

19 Utopian visions of other worlds, other times and other states of mind, and the quest of ideal society always function as social and political criticism. According to Henri Lefebvre, “utopia has been discredited, it is necessary to rehabilitate it. Utopia is never realized and yet it is indispensable to stimulate change.” Guy Debord’s *Society of the Spectacle* and Raoul Vaneigem’s *The Revolution of Everyday Life* presumes the total alienation of social relations in a space that is a mere collection of images, a stratum of commodities. Emphasizing the importance of imagination and encounters by chance in everyday life to change our perception of urban space, Debord argues that people should become aware of the ephemeral nature of the city and the next civilization to come. Henri Lefebvre, in Patricia Latour, Francis Combes, *Conversation avec Henri Lefebvre*, Paris: Messidor, 1991, pp. 18f.

20 Reyner Banham, “Softer Hardware,” in: *Ark*, Sommer 1969, p. 11.

21 Michel Tapié, *Un Art autre,* Paris: Gabriel Giraud et Fils, 1952.

22 Rem Koolhaas, “Junkspace,” in Rem Koolhaas, AMOMA et al., *Content.* Köln: Taschen, 2004, p. 171.

23 Sylvia Lavin, “Plasticity at Work,” in: Jeffrey Kipnis, Annetta Massie, ed., *Mood River*, Columbus, Ohio: Wexner Center for the Arts, 2002, p. 80.

24 Elisabeth Diller, *Blur Building, Yverdon-les-Bains, Swiss Expo.02*. in *Information zur Raumentwicklung*, 1.2005, pp. 15-16.

25 Randall Packer, “The Pepsi Pavilion: Laboratory for Social Experimentation,” in Jeffrey Shaw, Peter Weibel, eds., *Future Cinema. The Cinematic Imaginary After Film*. Cambridge, Mass.: The MIT Press, 2003.

26 Adolf Hildebrand, *Das Problem der Form in der bildenden Kunst* (1893), (The problem of form in the fine arts), in: Adolf Hildebrand: Gesammelte Schriften zur Kunst, Cologne: Westdeutscher Verlag, 1969, reprinted in: Mallgrave, Eleftherios Ikonomou, ed., *Empathy, Form and Space, Problems in German Aesthetics*, 1873-1893, Santa Monica, CA: Getty Center for the History of Art and the Humanities, 1994, p. 239.

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# The changes in Architecture Etrminology

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# The Changes in Architecture Terminology

The intention of this research is to inspire a discussion about the changes in architecture terminology with the revolution in communication and representation forms as a result of digitalisation. The blurred boundary between the virtual and the analogue worlds, the misunderstandings and the confusion that appear with the interaction of these two worlds nowadays form the major problems facing architectural design, education and research. The researchers in this field are focused on the interface, the meeting and the transformation point between the digital and analogue worlds in order to prevent those problems and confusions. One of the main reasons of this ambiguity is the architectural terminology that changes according to the changing status of architectural representation i.e. new forms of representation; new forms of communication i.e. the new role of the architect and the researcher.

Whenever and wherever information and knowledge specialised is created, communicated or transformed terminology is involved in a way or another. An absence of terminology is combined with an absence of an understanding of concepts. Therefore with the new information and communication technologies; new and developing subject areas the existence of terminology and its update is indispensable. Thus the changing status of the terminology must be analysed.

As architecture terminology is essential to improve today's challenging, multidisciplinary communication in order to clarify the problems of ambiguity and unawareness (as a result of shift of specific architectural vocabulary) it is necessary to analyse the changes in the architectural terminology which will form the discussion point of the following paper.

*As this paper is the beginning step of a research project which started on the occasion of the conference proposed by EAAE/ARCC we will here present only the objectives of this research, its general problematics, the methods that we wish to develop and some provisional results like the illustration of this approach to be followed.*

### 1. Introduction

The principal aim of this research is to observe the evolution of the vocabulary used in the field of architecture in the last 50 years. The challenge is initially on the epistemological level. Indeed in a cultural context that some named Post-modern (Lyotard, 1977) and which could be characterized by the end of the universal reasons and a dissemination of the individual enunciations, any theory as forms organized of concepts, offering a comprehension of architecture would become impossible. It is then the advent of multiple doctrines like as many discourses giving an interpretation of the architecture directed towards the action starting from presumedly true concepts. From this moment architecture takes place in a project of society in relation to a practice in conformity with an ethics.

The discourses on architecture become more and more unstable as a result of their own temporalities and changing referents. For example digital architecture calls into question the traditional forms of perception and suggests the advent of a new subjectivity.
We propose to seize these changes through the analysis of the discourses by identifying the new paradigms of architecture by making the assumption that it is in the interdiscourses or in the intertexts that a theory of architecture remains possible. Indeed the thought is not any more the characteristic of only one group of authors or a single theoretical space but takes part of a process of circulation of the ideas and practices which converge at a given time.

**2. Method**

The analysis of a discourse consists initially of a lexicological analysis using the tools of the lexicostatistics (or lexical statistics) which measures the frequency of the words in a text or a corpus of texts. This operation is automated by the use of certain suitable software of lexicographical analysis. It results in setting up a list of the most used words who characterize the lexicon of each author. In the second time, it is a question of carrying out a comparison of the lexicons to establish a typology of the authors and to determine their universes of reference that we call 'paradigms'.
In this first phase we put temporarily aside on one hand the question of the context i.e. all the extra linguistic determinations of the discourses which are related to the components of the situation of enunciation and on the other hand the question of lexical morphology and in particular the creation of neologisms which characterize a speech of speciality.
The study develops from both diachronic and synchronic point of view: The diachronic analysis seizes the semantic evolution of the words or their appearances as their disappearances or even their rarefaction in the discourses on architecture. Let us note that the same words used during different periods can correspond to different concepts according to ' universes of reference' to which they belong. Also the lexicological analysis makes it possible to see the appearing of a word in a corpus, and to see who has introduced it and on which date in order to create its history. The synchronic analysis aims to identify through the words employed in the discourses the universes of references which characterise the contemporary tendencies of architecture

*2.1 Constitution of the corpus*

The materials of study are the discourses on architecture and among all the forms of those discourses we will privilege the texts i.e. any discourse fixed by writing.
The corpus must be made up according to the principle of homogeneity: all the selected texts are on architecture even if their authors have different statutes (architects, urban planners, philosophers, theorists, historians, educators, researchers, critics, designers, artists, journalists...)
The principle of the 'reputation' of the authors has been taken into consideration in order to be able to be sure of the presence of the actors of the architectural debate over this period (being known either by their works in the professional or academic field, or by the prestigious prizes or awards obtained, or by their media influence...).
Several texts of the same author belonging to the same period or to different periods can be

presents in the corpus. They will make it possible to observe the evolution or the stability of the architecture terminology used by this author at the same time in ‘time’ and in ‘space’ of the theoretical or doctrinal positions.

The nature of the texts varies from an interview to a book, an article or a conference with various supports as architectural periodicals, scientific reviews, academic works, books, Internet sites, search engines specialized in architecture and sciences, newspapers.

In a later phase of the research, it will be necessary to distinguish the corpus according to the nature of their support, or the status of their authors in order to try to evaluate the impact of the forms of communication on the diffusion of the vocabulary of architecture and its theoretical effect.

The corpus currently includes 193 texts (both in English and in French) of 113 authors or author groups and consists the period from 1960 to 2008. Thereafter the corpus will be enlarged till 1955 to validate the diachronic study. The date ’1955’ has been proposed by Charles Jencks in his work ”Language of Post-Modern Architecture” (1979) to establish a typology of the architects according to the tendencies that he had noticed till 1980. This approach will possibly enable us to verify the interpretation of our own typology.

For the synchronic study we chose to consider periods of 10 years (in future, as the research progresses these periods will be transformed to 5 years).

The period 1960 – 1969 consists of 26 texts and 19 authors as the period 1970 – 1979 includes 28 texts and 20 authors. The period 1980 – 1989 is formed of 34 texts and 28 authors. The period of 1990 – 1999 includes 40 texts and 31 authors. The last period 2000 – 2008 is made up of 8 years and consists of 66 texts and 50 authors.

The length of the texts is variable between 215 and 11611 words for the current corpus. This corpus that we analyse here is composed of both English and French texts. The French texts will be the subject of translation.

*2.2 The analysis*

In the first phase of this research, we considered the texts of 5 periods (each of 10 years) from 1960 to 2008 and the results presented hereafter are related to those periods.

*2.2.1 Lexicon*

The method is at the same time inductive and then deductive: in fact the words identified by the lexicostatistics make it possible to set up a first list from which we retain the terms that are in connection with the field of architecture to establish the lexical and semantic field. For each text, the first 10 words the most used (frequency or a number of occurrences) among the substantives and the adjectives were retained to lead to the alphabetical index (see Annexes ’List 1’).

This analysis also permits us  to realize the necessary comparison between the 5 periods by identifying the repeating terms ( as architecture, aesthetics, building, culture, construction, history, nature, etc.), the new terms (as interactivity, interface, internet, hybrid, software, etc.), the new values (as ecology, green design, sustainable development, digital, virtual, etc.), the new meanings (as machine, surface, skin, etc.), or the words which rarefy (as function, theory, etc.)

posing the assumption of a language of generations. As the result of this analysis we can develop a hypothesis saying that there is a formal structure of the discourses on architecture but in time the content changes.
To hold account of the number of repetitions of the same word of a text and therefore of its real value we developed a system of 'balancing-ponderation' in order to establish a classification of the words most used for the whole of the corpus. The principle aim of this analysis is to clarify the difference of the placement of the word as the range therefore the value changes from the 1st to the 10th place. For example in the period of 2000-2008 the word 'Architecture' has a value of '252' and the word 'Conception' is the last word of the ponderation list with a value of '1'.
The 'Table of Ponderation' -listed below- shows the first 10 words (and their values) that take place in the lists of each of the 5 periods. That permits us to see the words that were the most important and frequent ones and their evolution in 50 years period.

The next phase of the research is to bring out the words that exist in each of the 5 periods and to repeat the lexicostatistic analysis - as we call 'Phase 2' – in order to set up a second list of terms that are in connection with the field of architecture. That enables us to deepen the analysis of each text and to identify the new terms, the universes of reference to which they belong to and the evolution of those universes of reference. The words that are  frequently used in each period can be listed as - aesthetics, art, building, city, complex, culture, design, energy, environment, form, history, human, life, idea, ideology, image, language, meaning, nature, natural, modern(ism), pattern, people, place, post-modern(ism), project, structure, system, technique, technology, theory, work, world . As a result of the lexicostatistic analysis of 'Phase2' for the period of 2000-2008 we were able to bring out 118 new terms that enabled us to deepen in the content of the texts, therefore the new discussion subjects, values and possible theories on architecture. Some of these new terms can be listed as -architectextile, argue, censure, crisis, elasticity, internet, manifestation, mathematics, metaphor, politics, prototype, screen, sequence, sustainable, tectonic, virtual-reality, vision, etc.

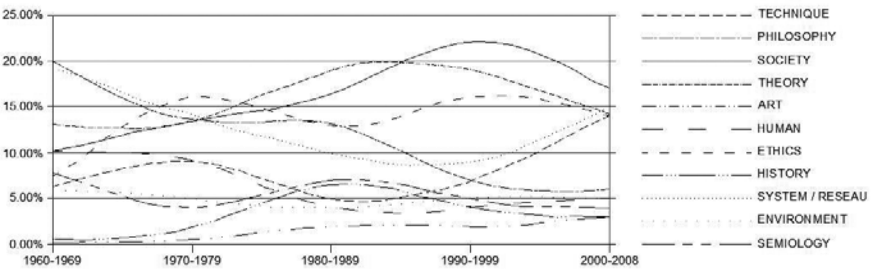
*2.2.2 Universe of reference*

It is then a question of identifying the paradigms as sets of words which indicate the same referent. These words are used in coherence.  We will notice that the same word by its polysemous character can belong to several universes of reference -as ecology, conception, hybrid, metaphor, organism, process, relation(ship), solution, etc.
The choice of the words and the creation of the universes of reference were mainly done by two factors. The usage of one software specialized on the analysis of the texts and the judgement of knowledge of the analyst (see Annexes 'List 2').
The table of the 'Evolution of Universes of Reference' -listed below- enables us to see the changes of the weight, therefore the importance and the power of the universes of reference in 50 years period. At this point of the research, according to the results, we are able to develop hypothesises  like, technology gaining importance in the last period, philosophy living its place to moral philosophy as the ethics gains importance, society transferring into more the idea of

| | 1960-1969 | | 1970-1979 | | 1980-1989 | | 1990-1999 | | 2000-2008 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 26 texts | | 28 texts | | 34 texts | | 40 texts | | 66 texts | |
| | WORD | VAL. | WORD | VAL. | WORD | VAL. | WORD | VAL. | WORD | VAL. |
| 1 | FORM | 59 | ARCHITECTURE | 110 | ARCHITECTURE | 192 | ARCHITECTURE | 257 | ARCHITECTURE | 252 |
| 2 | MEANING | 50 | BUILDING | 62 | BUILDING | 81 | ARCHITECT | 79 | SPACE | 198 |
| 3 | PROBLEM | 47 | CITY | 49 | FORM | 78 | DESIGN | 74 | NEW | 170 |
| 4 | CITY | 41 | ARCHITECT | 43 | DESIGN | 48 | BUILDING | 73 | DESIGN | 157 |
| 5 | BUILDING | 29 | URBAN | 43 | CITY | 40 | CITY | 73 | BUILDING | 108 |
| 6 | DESIGN | 29 | FORM | 43 | URBAN | 35 | NEW | 52 | PROJECT | 92 |
| 7 | ORGANIZATION | 28 | SPACE | 37 | NEW | 35 | SPACE | 50 | CITY | 89 |
| 8 | TIME | 26 | SYSTEM | 36 | CULTURE | 27 | WORK | 45 | FORM | 87 |
| 9 | ENVIRONMENT | 25 | NEW | 35 | SPACE | 25 | PROJECT | 41 | WORK | 80 |
| 10 | LIFE | 25 | DESIGN | 33 | MEANING | 24 | FORM | 39 | ARCHITECT | 68 |

**Table of ponderation**

| UNIV. REFERENCES | 1960 – 1969 | 1970 – 1979 | 1980 – 1989 | 1990 - 1999 | 2000 – 2008 |
|---|---|---|---|---|---|
| TECHNIQUE | 6,00% | 9,00% | 5,00% | 7,00% | 14,00% |
| PHILOSOPHY | 20,00% | 13,50% | 13,00% | 7,00% | 6,00% |
| SOCIETY | 10,00% | 13,50% | 16,50% | 22,00% | 17,00% |
| THEORY | 13,00% | 13,50% | 19,00% | 19,00% | 14,00% |
| ART | 0,20% | 0,50% | 2,00% | 2,00% | 3,00% |
| HUMAN | 10,00% | 9,00% | 4,00% | 4,00% | 5,00% |
| ETHICS | 7,00% | 16,00% | 13,00% | 16,00% | 14,00% |
| HISTORY | 0,40% | 2,00% | 6,50% | 4,00% | 3,00% |
| SYSTEM / RESEAU | 19,40% | 14,00% | 10,00% | 9,00% | 15,00% |
| ENVIRONMENT | 6,00% | 5,00% | 4,00% | 5,00% | 5,00% |
| SEMIOLOGY | 8,00% | 4,00% | 7,00% | 5,00% | 4,00% |




**Evolution of universes of references**

'social relationships', environment changing the content... from more general to specific character with the words as eco-system, biosphere, sustainable development, green design, hybrid, etc., having no more hierarchical share between nature and culture...
In order to deepen in the content of the texts, therefore more detailed weight of the universes of reference it is necessary to make a comparison between the 'Phase 1' and 'Phase 2' of lexocostatistic analysis. The table of 'Universes of reference 2000-2008 Phase 1 & Phase 2' sheds light on the changes of the weight of the universes of reference for the period 2000-2008. As a result of this representation it is possible to observe the increase of the weight of 'philosophy' and the non-existence of 'art' and 'history.

*2.2.3 Typology*
The next challenge-aim of the research is to identify the obvious relations between the words, words and authors, and the possible regroupings. For that purpose we used a software of statistical analysis carrying out the analysis of the correspondences as the principle of explanation and also allowing the identification of the same groups of affinity. Therefore we retained the first 10 words of each text to establish the first typology starting from the statistical processing of a table 'attribute-object' where the authors are characterized by the words which they use.
The following two representations of periods of 1990-1999 and 2000-2008 will permit us to identify and understand the eventual evolution of architecture terminology in the last 10 years of the last century and the first 8 years of the 21st century. The aim will be to enlarge this analysis into 50 years in coming time.

In the representation of 'Factorial Analysis of Correspondences Period 2000-2008', in a system of axes, we realize that the whole of the components are organized around a first horizontal axis which can be interpreted as the axis "technological to social". The 'technological' dimension is indicated by the words "construction, material, perspective, physical, software, surface..." and the 'social' dimension by the words "city, communication, culture, junkspace, media, movement...". The vertical axis is interpreted as the axis "theoretical to practical". The 'theoretical' dimension is defined by the terms "complexity, conception, design, planning, question..." and the 'practical' dimension by the terms "builtform, fabric, function, language, pattern, textile...". These axes define 4 quadrants which contain each a group of components belonging to a certain characterized type.
The 1st type that we named as "theoretical-social" is characterized by the universes of references related to the society, theory, ethics, history and art. We find in this group the authors who are mainly theorists, historians like K. Frampton, J. Pallasmaa, Ch. Jencks. That seems coherent with the known status of these authors.
The 2nd type is called "theoretical-technique" and it is characterized by the universes of references technical, theoretical, philosophical, system-network and human. This quadrant mainly consists the terms related with the new way of representation and values related with new technology. We can find in this group the architect-author-educators like P. S. Cohen, P. Schumacher, K. Yeang, N. Callicott, M. Hengel and D. Sunguroglu. Here the bringing together of the

| UNIV. REFERENCE | PHASE 1 | PHASE 2 |
|---|---|---|
| TECHNIQUE | 14,00% | 11,00% |
| PHILOSOPHY | 6,00% | 11,00% |
| SOCIETY | 17,00% | 18,00% |
| THEORY | 14,00% | 15,00% |
| ART | 3,00% | 2,00% |
| HUMAN | 5,00% | 5,00% |
| ETHICS | 14,00% | 16,00% |
| HISTORY | 3,00% | 1,00% |
| SYSTEM / RESEAU | 15,00% | 14,00% |
| ENVIRONMENT | 5,00% | 3,00% |
| SEMIOLOGY | 4,00% | 4,00% |

**Universes of reference 2000-2008 Phase 1 & phase 2**

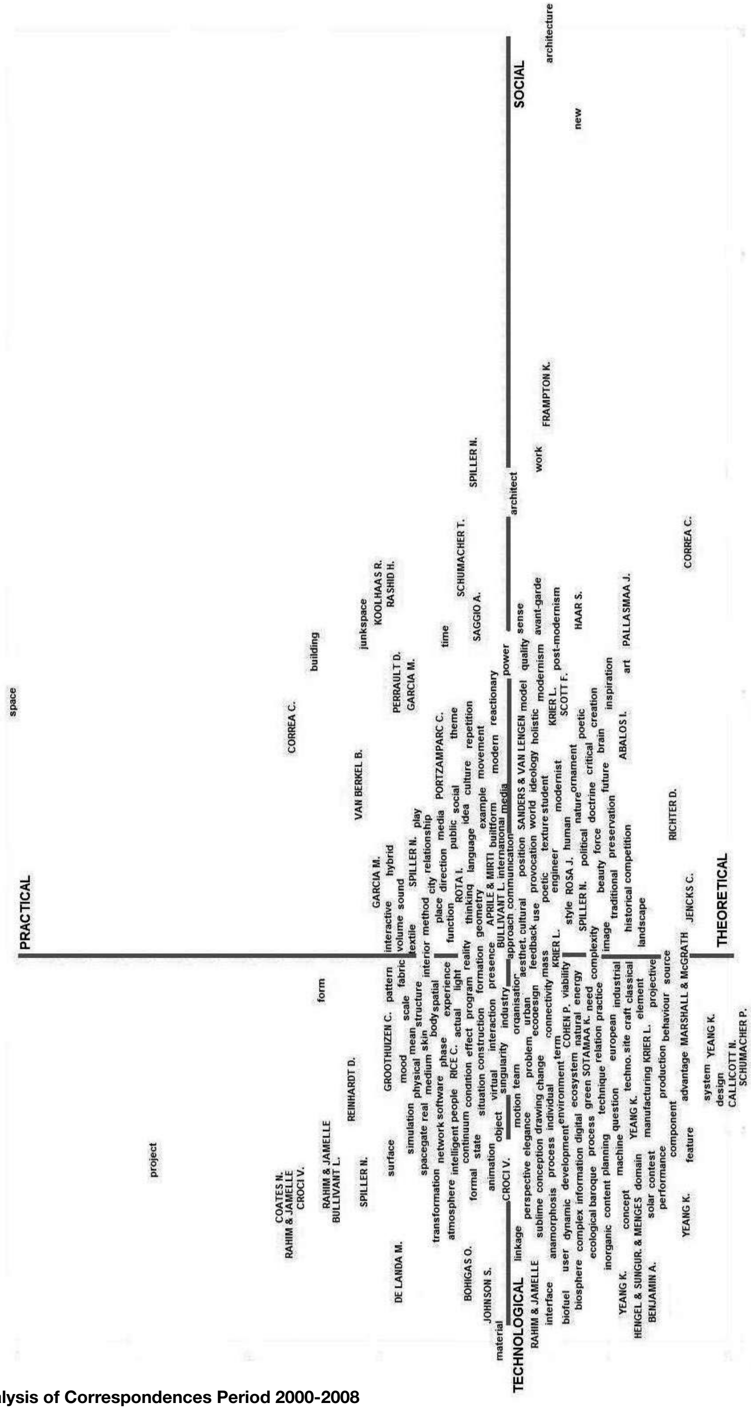
question of the relationship between the Technique and the Man seems as the continuation of the philosophical reflection of M. Heidegger.

The 3rd type named ”practical-technical” contains mostly technical and system-network references and the authors are mostly the architects, experts and critics like V. Croci, L. Bullivant, S. Johnson, Rahim&Jamelle, C. Groothuizen which comment on the tendencies of architecture using new technologies. The new way of ’communication’ with new technological possibilities can be identified as the dominant concept of this quadrant.

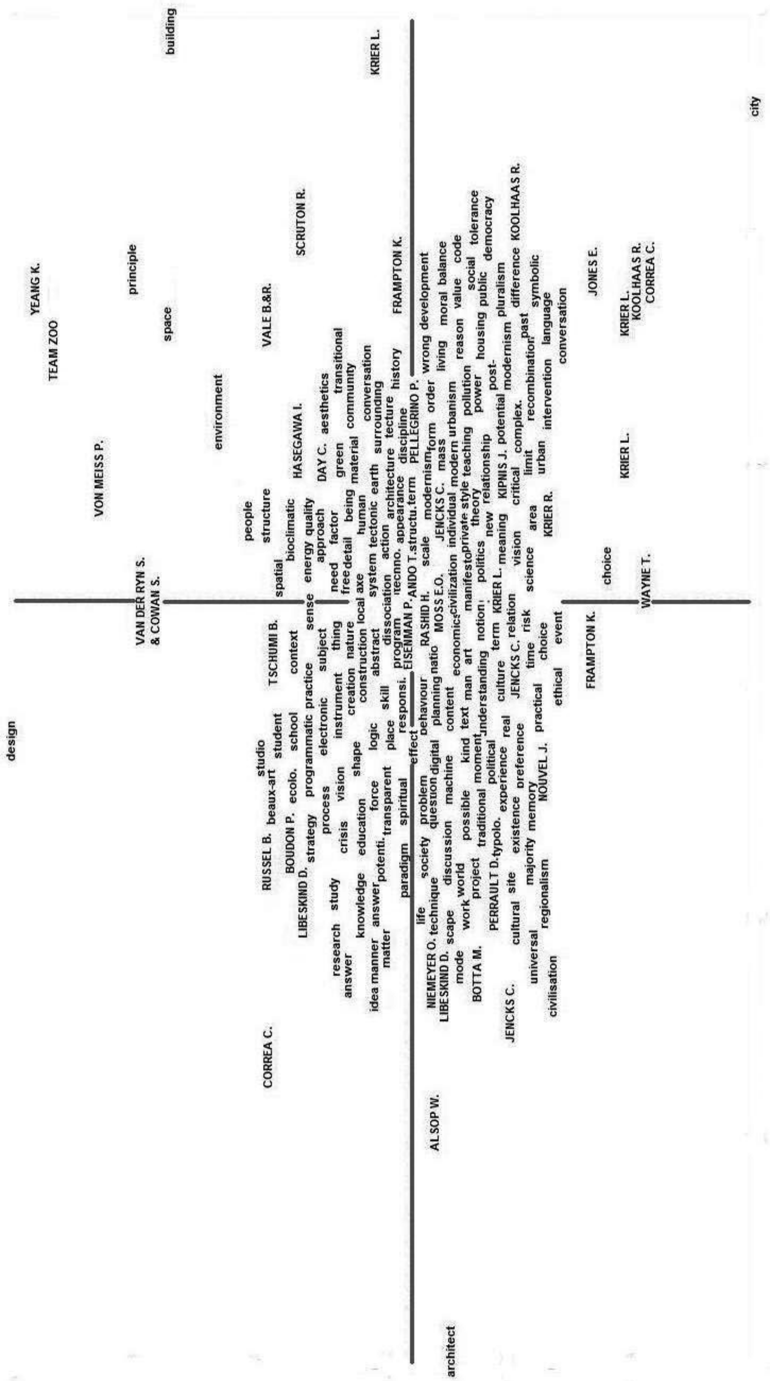
The 4th type named ”practical-social” concernes mainly technical and social references. We find in this group the architects-researchers-educators who write about and present new technologies as N. Spiller, W. Aprile, S. Mirti, M. Garcia, A. Saggio and architects who use new technologies, have an international activity and are present in the media like H. Rashid (Asymptotic), Rahim & Jamelle, C. Portzamparc, R. Koolhaas, D. Perrault, B. van Berkel.

It will remain to specify these configurations according to the enrichment of the corpus of texts and by comparison with the former periods.

For the period 1990-1999, the categorization of the texts and their authors are less obvious than the period 2000-2008, but we can however note that the terms related to the questions of society (22%) are present in the whole of the texts. Two groups of universes of reference can be identified on both sides of the horizontal axis. The words which shows rather an ethical (16%) positioning as ‘ethical, choice, discussion, critical, tolerance, value, moral, wrong, pluralism, preference, political, responsible, difference’ characterizing the first group in which we find architects practitioners and/or theorists like J. Nouvel, D. Libeskind, Mr. Botta; R. Koolhaas, D. Perrault, W. Alsop, but also Ch. Jencks, L. Krier, C. Correa, K. Frampton. The second group has rather theoretical (19%) preoccupations defined by the words ‘strategy, process, research, logic, paradigm, abstract, program, system, discipline, system, dissociation’. It is possible to find in this group Ph. Boudon, B. Russel, B. Tschumi, D. Libeskind (known at the same time as practitioner and theorist), S. Van der Ryn & S. Cowan... In a context where the advent of new technologies as well as the emergence of environmental preoccupations take place, this period correspond to a reflexion focused on the social utility of the innovations associated with a discussion on the risks that these new objects can generate. The question of ethics is then indissociable from the questions of society. The theory relates to more the procedures than the products




Factorial Analysis of Correspondences Period 2000-2008




Factorial Analysis of Correspondences Period 1990-1999 integrating an ethical point of view on the manner of transforming our society. In this state of the culture, the topics of art and history seem to take less importance in the field of architecture. This observation remains a subject of deepening in comparison with the development of the concept of 'heritage' and a new phenomenology suitable to transform our aesthetical vision of the world.

**3. Provisional Results**

3.1 We can consider that the structure of the field of architectural theory rests largely on the explicit or implicit relations of the discourses among themselves i.e. on the interdiscourses. Each discourse indeed takes a direction in a form of dependence to the other discourses by partly sharing the universes of references in which they are the various combinations of words which make it possible to identify a discourse, which is what makes its singularity even its new character.

3.2 The analysis of the discourses on architecture raises the question of a specific language, set of themes suitable to found the architectural discipline.

3.3 We can also wonder about the theoretical value of the discourses by the examination of the lexicons used, the use of general or specific terms which can result either in 'talking to say nothing' (neutral terms) or to set up concepts that base on a lexicon of speciality.

3.4 The diachronic study should show an evolution of the vocabulary, the appearance, the transformation, the disappearance or the continuity of the paradigms. Therefore we could identify some new terms like "interactivity, interface, Internet, hybrid, software...", new values as "ecology, green design, sustainable development, digital, virtual", new meanings like "machine, surface, skin..." or words which rarefy like "function, theory..." posing the assumption of a language of generations.

3.5 The assumption of a local language whose challenge is the question of interculturality also remains to be checked. For example is there a specific architectural thought by its own in the Anglo-Saxon world influenced by the use of a language?

3.6 Is it possible to realize a project of a dictionary of terms of the architectural discourses conceived as a bank of data which should be updated permanently within the framework of an international collaboration?

3.7 Finally the reality does not pre-exist in the discourses but is built by the discourses, theory or doctrines, which evoke a possible world and justify the study that we propose to realize.

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## LIST 1. 'THE FIRST 10 MOST COMMONLY USED WORDS'

**Period 1960-1969**

Aesthetics, Ambiguity, Analyse, Analysis, Aptitude, Architect, Architecture, Area, Art, Artefact, Awareness, Building, Change, City, Complex, Complexity, Component, Concept, Conception, Confidence, Conflict, Connection, Context, Contradiction, Control, Craftsman, Creation, Creator, Culture, Design, Desire, Destruction, Development, Diagram, Discipline, Dissociation, Double, Dynamic, Ecology, Edge, Element, Elimination, Energy, Environment, Environmental, Equivoque, Evolution, Express, Expression, Fact, Fitting, Flexibility, Form, Function, Heterotopia, History, Historical, House, Housing, Human, Humanity, Idea, Image, Individual, Information, Innocence, Intellect, Knowledge, Landmark, Landscape, Language, Lattice, Life, Light, Logic, Man, Mass, Material, Meaning, Mechanical, Mega structure, Mega-word, Metaphor, Method, Mind, Model, Modern, Monument, Multivalent, Natural, Nature, Negentrophy, Node, Nothing, Obligation, Obsolescence, Order, Organisation, Organism, Participation, Passionate, Path, Pattern, Peasant, People, Physical, Place, Planning, Principle, Problem, Process, Productivity, Project, Real, Reality, Reference, Relation, Relationship, Research, Reseau, Science, Self-confidence, Sense, Sign, Site, Society, Solution, Something, Space, Structure, Support, System, Technique, Technology, Term, Thing, Thought, Time, Town, Tradition, Tree, Truth, Unit, Unity, Unselfconsciousness, Urban, Village, What 148

**Period 1970-1979**

Alive, Analogical, Anti-scheme, Architect, Architecture, Archetypical, Aspect, Attitude, Belief, Block, Body, Boundary, Bricolage, Building, Capitalist, Choice, Choreography, City, Coincidence, Collage, Collision, Concept, Conception, Condition, Construction, Context, Continuum, Contradiction, Conventional, Creation, Critical, Criticism, Cultural, Culture, Delight, Design, Desire, Desolation, Development, Dialectic, Different, Dimension, Drawing, Dynamic, Economical, Electronics, Element, Energy, Environment, Everything, Existing, Experience, Explicit, Flow, Force, Form, Formal, Function, Functionalist, Future, Geometrical, Geometry, Great, Growth, Heroic, Hierarchy, History, Human, Humanist, Idea, Ideal, Ideology, Image, Information, Institution, Integral, Interest, Interpretation, Landscape, Language, Level, Life, Light, Limit, Man, Manifesto, Meaning, Memory, Method, Mind, Modern, Modernism, Morphology, Motion, Movement, Natural, Nature, Need, New, Object, Objective, Order, Ordinary, Original, Paradigm, Pattern, People, Piece, Place, Pleasure, Political, Politics, Population, Preference, Problem, Project, Public, Quality, Quarter, Radical, Rational, Realisation, Reality, Reconstruction, Relation, Relationship, Research, Result, Retroactive, Satisfactory, Sculpture, Sign, Size, Society, Solution, Space, Spatial, Spirit, Square, Street, Structure, Suburb, System, Technique, Technology, Tendency, Term, Text, Theoretical, Theory, Thought, Thick, Town, Type, Typology, Unbalancing, Understanding, Urban, Volume, Waste, Word, World 166

**Period 1980-1989**

Action, Aesthetics, Age, Approach, Architect, Architecture, Area, Art, Aspect, Avant-Garde, Basic, Beauty, Building, Capacity, Centre, Changement, Changing, City, Classical, Classicism, Cohesion, Component, Concept, Condition, Connection, Construction, Constructional, Context, Contradiction, Critic, Critical, Cultural, Culture, Decision, Deconstructivist, Density, Design, Developer, Difference, Dimension, Discourse, Disjunction, Diversity, Domestic, Drawing, Dream, Eclecticism, Economic, Effect, Element, Enclosure, End, Energy, Environment, Equality, Expression, External, Face, Filed, Figurative, Flexible, Form, Formal, Functional, Future, Geometry, Great, Group, Historical, History, Housing, Human, Idea, Ideology, Image, Imagery, Individual, Industrial, Innovation, Knowledge, Landscape, Laws, Legible, Life, Light, Logic, Material, Mathematical, Meaning, Metaphor, Metaphysical, Method, Model, Modern, Modernism, Modernist, Movement, Myth, Nature, Negotiation, Neighbourhood, New, Not-classical, Notion, Object, Open, Order, Origin, Pattern, People, Phenomena, Physical, Place, Plan, Plurality, Popular, Post-Modernism, Power, Principle, Private, Problem, Process, Product, Program, Project, Psychological, Public, Pure, Question, Radical, Randomness, Ratio, Rational, Realisation, Reality, Realm, Regionalism, Regionalist, Relation, Renovation, Representation, Role, Rule, Rupture, Science, Shelter, Side, Signification, Site, Situation, Skill, Social, Society, Sociological, Solution, Source, Space, Strategy, Structure, Style, Structure, Style, Surface, Symbiosis, Symbol, System, Team, Tectonic, Tendency, Thematic, Theme, Theory, Thinking, Time, Timeless, Tradition, Traditional, Transform, Transformation, Translate, Universal, Urban, Utopia, Value, Vernacular, View, Village, Volume, Work, World, Writing, Zoning 194

**Period 1990-1999**

Abstract, Action, Aesthetics, Answer, Appearance, Approach, Architect, Architectural, Architecture, Area, Art, Axe, Balance, Beaux-Art, Behaviour, Being, Bigness, Bioclimatic, Building, Choice, City, Civilisation, Code, Community, Complexity, Conversation, Construction, Content, Context, Conversation, Course, Creation, Crisis, Critical, Cultural, Culture, Democracy, Design, Detail, Development, Difference, Digital, Discipline, Discussion, Dissociation, Earth, Ecological, Ecology, Economics, Education, Electronic, Effect, Energy, Environment, Ethical, Event, Existence, Experience, Facture, Figure, Folding, Force, Form, Free, Green, Height, History, Housing, Human, Idea, Individual, Instrument, Intervention, Kind, Knowledge, Language, Life, Limit, Living, Local, Logic, Machine, Majority, Man, Manifesto, Manner, Mass, Material, Material, Meaning Memory, Mode, Modern, Modernism, Moment, Moral, National, Nature, Need, New, Notion, Object, Order, Paradigm, Past, People, Place, Planning, Pluralism, Plurality, Political, Politics, Pollution, Possible, Post-Modern, Post-Modernism, Potential, Power, Practical, Practice, Prediction, Preference, Principal, Principle, Private, Problem, Process, Program, Programmatic, Project, Public, Quality, Question, Real, Reason, Recombination, Regionalism, Relation, Relationship, Research, Responsibility, Risk, Scale, Scape, School, Science, Sense, Shape, Site, Skill, Social, Society, Space, Spatial, Spiritual, Strategy, Structural, Structure, Student, Studio, Study, Style, Subject, Surrounding, Symbolic, System, Teacher, Teaching, Technique, Technology, Tectonic, Term, Text, Theory, Thing, Time, Tolerance, Traditional, Transitional, Transparent, Typology, Understanding, Universal, Urban, Urbanism, Value, Vision, Work, World, Wrong 192

**Period 2000-2008**

Actual, Advantage, Aesthetics, Anamorphosis, Animation, Approach, Architect, Architectural, Architecture, Art, Atmosphere, Attractor, Avant-Garde, Baroque, Beauty, Behaviour, Behavioural, Biofuel, Biosphere, Body, Brain, Building, Builtform, Camouflage, Change, City, Classical, Communication, Competition, Complex, Complexity, Component, Composition, Concept, Conception, Condition, Connectivity, Construction, Content, Contest, Continuum, Craft, Creation, Critical, Cultural, Culture, Design, Designer, Development, Difference, Digital, Direction, Display, Doctrine, Domain, Drawing, Dynamic, Ecodesign, Ecological, Ecosystem, Education, Effect, Elegance, Elegant, Element, Energy, Engineer, Engineering, Environment, European, Example, Exclusion, Experience, Fabric, Fabrication, Feature, Feedback, Flow, Force, Form, Formal, Formation, Function, Future, Geometry, Green, Historic, Holistic, Human , Hybrid, Idea, Ideology, Image, Imagined, Individual, Industrial, Industry, Information, Inorganic, Inspiration, Intelligent, Interaction, Interactive, Interactivity, Interface, Interior, International, Junckspace, Landscape, Language, Light, Linkage, Local, Machine, Manufacturing, Mass, Material, Mean, Media, Medium, Method, Model, Modern, Modernism, Modernist, Mood, Motion, Movement,Natural, Nature, Need, Network, New, Object, Organisation, Ornament, Paranoiac-Critical, Patch, Pattern People, Performance, Perspective, Phase, Photobioreactor, Physical, Piece, Place, Planning, Play, Poetic, Political, Position, Possibility, Post-Modernism, Potentiality, Power, Practice, Presence, Preservation, Prisoner, Problem, Process, Production, Program, Project, Projective, Provocation, Public, Quality, Question, Reactionary, Real, Reality, Relation, Relationship, Repetition, Scale, Sense, Shade, Simulation, Singularity, Site, Situation, Skin, Social, Software, Solar, Sound, Source, Space, Space gate, Spatial, State, Structure, Student, Style, Sublime, Surface, System, Team, Technique, Technology, Term, Textile, Texture, Theme, Thinking, Time, Tradition, Traditional, Transformation, Urban, Urbanism, Use, User, Viability, Virtual, Visual, Volume, Work, World 220

**LIST 2. 'THE UNIVERSES OF REFERENCE'**

**Period 1960-1969**

| UNIVERSES OF REFERENCE | PERCENT. | WORDS |
|---|---|---|
| TECHNIQUE | 6.00% | Building, component, element, light, material, mechanical, megastructure, structure, technical, technology... |
| PHILOSOPHY | 20.00% | Ambiguity, artefact, change, concept, conception, contradiction, double, ecology, equvoque, evolution, fact, heteropia, idea, language, life, light, logic, material, metaphor, multivalent, nothing, order, organism, philosophy, reality, reference, sense, thing, thought,time, truth, unity, unselfconsciousness, what... |
| SOCIETY | 10.00% | Architect, area, city, craftsman, culture, development, evolution, house, housing, mass, peasant, people, place, productivity, realtionship, society, town, urban, village, ... |
| THEORY | 13.00% | Analyse, concept, conception, creation, design, discipline, dissociation, fitting, idea, knowledge, logic, method, model, pattern, principle, problem, process, project, research, science, solution, term, tree... |
| ART | 0.20% | Aesthetics, art, ... |
| HUMAN | 10.00% | Aptitude, creator, desire, evolution, human,individual, innocence, intellect, landmark, life, man, mind, passionate, path, physical, self confidance, unselfconsciousness... |
| ETHICS | 7.00% | Awareness, confidence, conflict, destruction, ecology, elimination, ethics, mind, obligation, order, participation, truth, ... |
| HISTORY | 0.40% | Historic, historical, history, modern, monument, tradition, ... |
| SYSTEM/RESEAU | 19.40% | Artefact, complex, complex, connection, control, diagram, dynamic, element, energy, flexibility, function, information, lattice, megastructure, megaword, method, model, negentrophy, network, node, obsolescence, order, organisation, pattern, planning, relation, reseau, solution, structure, support, system/reseau, tree, unit, ... |
| ENVIRONMENT | 6.00% | Context, development, ecology, environment, landscape, natural, nature, organism, site, ... |
| SEMIOLOGY | 8.00% | Double, express, expression, form, image, language, meaning, meta phor, multivalent, sense, sign, ... |

**Period 2000-2008**

| UNIVERSES OF REFERENCE | PERCENT. | WORDS |
|---|---|---|
| TECHNIQUE | 14.00% | Animation, building, builtform, component, construction, digital, drawing, energy, engineering, fabric, fabrication, geometry, green, industrial, industry, light, machine, material, perspective, photo-bioreactor, physical, power, shade, skin, software, solar, sound, spacegate, structure, surface, technique, technology, textile, texture, volume, ... |
| PHILOSOPHY | 6.00% | Difference, doctrine, green, holistic, hybrid, idea, ideology, intelligent, linkage, machine, nature, projective, real, reality, thinking, ... |
| SOCIETY | 17.00% | Actual, architect, change, city, complex, continuum, craft, creation, cultural, culture, designer, development, dynamic, education, european, exclusion, formation, ideology, individual, industrial, industry, interior, international, junkspace, local, mass, media, medium, mood, movement, need, new, people, public, relationship, similarity, social, student, team, traditional, urban, urbanism, use, user, work, world, ... |
| THEORY | 14.00% | Advantage, approach, complex, composition, concept, conception, condition, content, design, domain, ecodesign, example, experience, form, formal, function, method, object, patch, pattern, planning, pos-siblity, practice, problem, process, production, program, project, question, repetition, scale simulation, source, space, spatial, theme, ... |
| ART | 3.00% | Aesthetics, art, Baroque, beauty, poetic, style, sublime, ... |
| HUMAN | 5.00% | Behaviour, behavioural, body, brain, human, individual, inspritation, modernist, paranoiac critical, poetic, user, visual, ... |
| ETHICS | 14.00% | Atmosphere, avantgarde, camouflage, change, competition, contest, critical, difference, direction, ecodesign, ecological, elegance, elegant, european, exclusion, force, future, green, ideology, international, link-age, motion, ornament, physical, political, position, power, pre-servation, prisoner, provocation, quality, reactionary, relation, solar, viability, world, ... |
| HISTORY | 3.00% | Avantgarde, Baroque, classical, historic, modern, modernism, modernist,... |
| SYSTEM/RESEAU | 15.00% | Attractor, communication, complexity, component, connectivity, development, digital, display, effect, element, energy, feature, feed-back, flow, function, information, interaction, interactive, interactivity, interface, network, organisation, pattern, performance, phase, piece, play, possiblity, potentiality, presence, relationship, simulation, source, state, structure, system, term, time, transformation, virtual, ... |
| ENVIRONMENT | 5.00% | Biofule, biosphere, ecosystem, environment, hybrid, inorganic, land-scape, natural, nature, place, site, situation, ... |
| SEMIOLOGY | 4.00% | Anamorphosis, image, imagined, language, mean, sense, surface, virtual, visual,... |

Adri Proveniers

# ICT and Architectural Theory and History: from Literary Discourse to Design Paradigms?

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Adri Proveniers

# ICT and Architectural Theory and History: from Literary Discourse to Design Paradigms?


**Abstract**

*Design Studio Practice in the ICT – Google Era*

As a jury on Architectural projects we all recognise the unpleasant feeling when we hear a too highly polished student ICT-presentation: the plan does not correspond with the literary plea.

*Strong Literary Tradition*

Architectural Theory and History have a strong literary tradition.

Starting from the present ICT developments and out of here resulting social trends the literary approach gets more and more under pressure.

With help from Google it almost seems possible to link all concepts in random order, to randomize pro and contra arguments and to compose and decompose them in an almost endless way.

The literary plea loses its strength and can only be judged as an essay on its literary significance.

Realistic working Design Paradigms are missing.

*Issue*

Due to this it will be more and more problematic to frame young architects into Architectural History and Architectural Theory in an academic reliable way.

Therefore the 'white spots' will be filled up in one way or the other, if necessary by other disciplines.

Especially the literary branch of Architectural History and Theory may run a serious risk to degenerate to the Regional Chamber of Rhetoricians in the local University Pub?

*Paper*

With help of some 'old and cold Theories' from the past:

- Edmund Burke on the meaningless enjoyment of literary prose
- Jacques Derrida on the - already in the past – existing gap between a word and the different meanings of that word
- Arthur Danto on the Philosophic-Theoretical Ending of Arts true Technology

This paper situates the gigantic opportunities of ICT and the attractive force of poetry against other new trends:

- The 'explosion in Architectural Styles' true the economic growth of the nineties
- Reduction in actual instruction time for Architecture in new Bachelors – Masters Structure
- The basic Black Box Character of Architectural Design Studio Education

Based on this theoretic, educational and pragmatic analyses the Paper makes a plea for a third approach: realistic working Design Paradigms, next to the two main lines of Architectural History and Architectural Theory.
And next to it: a plea for a separate category in Design Studio Critics: The Archi-Formance (a contradiction of Architecture and Performance) for literary, visual and conceptual prose in Architecture.
For in the new ICT – Google Era we can not deny the new methodological context of Archi-Formance: (International) design competitions are also flooded with it.
We should make a separate category of it and next to it we should look through the highly metaphoric design to more meaningful aspects of the design.

**Paper**

*Design Studio Practice*

*As a Jury on Architectural projects we all recognise the unpleasant feeling when we hear a too highly polished student presentation: the text is sublime and the pictures are smashing. But does the text correspond with the pictures? And corresponds this all with the future reality of the building?*

**The Gap between what ought to be in the plan and really is**

Already Vitruvius places the Architect in the Centre of the Universe. The Architect has to have knowledge of almost all the existing Sciences of those days: writing of Treatises, Drawing, Sketching, Geometry, Optics, Arithmetic, Architectural History, Philosophy, Music, Acoustics, Medicine and Metrology, Astronomy, Law, Economics, and Earth Sciences.
In this way Vitruvius paved the way for the uneasy and ever lasting gap between what ought to be in the plan and what really is.

Vitruvius in Book I chapter 1: The Education of the Architect verse 1: “The Architect should be equipped with knowledge of many branches of study and varied kinds of learning, for it is by his judgement that all work done by the other Arts is put to test. This knowledge is the child of practice and theory. Practice is the continuous and regular exercise of employment where manual work is done with any necessary material according to the design of a drawing. Theory, on the other hand, is the ability to demonstrate and explain the productions of dexterity on the principles of proportion.”

Verse 2: “It follows, therefore, that Architects who have aimed at acquiring manual skill without scholarship have never been able to reach a position of authority to correspond to their pains, while those who relies only upon theories and scholarship were obviously hunting the shadow, not the substance. But those who have a thorough knowledge of both, like men armed at all points, have the sooner attained their object and carried authority with them.”

Regarding to Pytheos, who said that the Architect should be leading top-class on all those different Arts and Sciences (Vitruvius, Book 1, prologue, verse 12) Vitruvius comments that that is virtual impossible. Vitruvius points out to Pytheos that all Arts and Sciences are composed of two things: the actual craft work and the Theory of it (ibid, verse 15)
“The actual undertaking of works which are brought to perfection by the hand and its manipulation is the function of those who have been specially trained to deal with a single art” (ibid, verse 16).
“The Theory is shared with other scholars” (ibid, verse 15), because “in all Sciences many points, perhaps all, are common so far as the discussion of them is concerned” (ibid, verse 16) (logic and methodology)
“It appears, therefore, that he has done enough and to spare who in each subject possesses a fairly good knowledge of those parts, with their principles, which are indispensable for Architecture that he is capable to pass judgement and to express approval in the case of those things or Arts” (ibid verse 16).

**Strong Literary Tradition in Architectural Theory**

Architectural Theory has a strong literary tradition. The literary prose is an essential part of the Design Concept.

The ten Books of Vitruvius are well known for there strong Technical Theoretical Fundamentals and for his introduction of the human proportions as a frame to the whole: the famous Icon of men standing in the centre of both and square and outer circle.
But, to point out some origin, perception and cultural meaning to Architecture, he also uses a kind of literary prose with partly historicized, partly theological, partly mythical origins. For example the mythical origin of Society, living together and building (book 2, chapter 1) and the origins of the ‘classic orders’ in warriors, gods and goddesses (book 4, chapter 1)

The literary prose has a very important bridging role between what is in the plan and what could be. The literary prose has obviously a very important artistic role as cultural enjoyment as well.
The sublime texts from Adolf Loos and the powerful language of the numerous manifesto’s. The pulses of the rhythm. The creative imagination of the metaphors. The instinctive floating away on the waves of the literary plea …..

The well-known conservative Philosopher Edmund Burke as well as the post-structuralism Philosopher Jacques Derrida pose that there is a gap between words and meaning.

Edmund Burke, who bases his theory on the rational-empirical Philosopher John Locke, makes a distinction in the sound of a word, in the image what the word creates in our minds and in the feeling what the word creates in our harts.
Not all types of words create those three effects together.
The distinguished ‘composite abstract words’ (as honour, justice, freedom, et cetera) only pro-

duce sound and feeling and no image.
Only the types of words called 'simple abstract words '(blue, green, hot, cold) and the types of words called 'joined words' (castle, horse) give all: sound, image and feeling. But not when these words are a part of a large text. Then there is no room for an image.
So Edmund Burke concludes that there is text what creates feelings without the creation of images. In this way he explains the pure – meaningless – cultural enjoyment of literary prose (Burke, 1757).

The post-structuralism Philosopher Jacques Derrida poses that no linguistic expression is bounded to a well-defined context. Every text belongs to an original and real context. The more frequent certain words are used in a certain context, the less ambiguous the – temporary – bond between the acoustic 'signifier' (for example the word 'tree') and the 'signifies' (the understanding 'tree').
So has the Dutch word 'boom' (English word 'beam') in maritime conventions a quite different meaning than in housing construction conventions.
In for example Politics, Architecture, Economics, et cetera, there is a continuous creative use of words, which lets to a continuous shift in meaning in gradual stages.
The relation between 'signifier' and 'signified' is stretched continuous which leads constant to 'something new', whereas written language presupposes a continuation in meaning. This dynamic tension in language between a fixed meaning and a shifting in meaning characterizes Derrida with the French expression 'différance', what means 'delay' (in this case: delay of a new meaning for that particular word) as well as 'difference' (in this case: a new meaning for that particular word).
With the practice of metaphors one conscious and on purpose uses the stretched shift in meaning. And, in terms of Edmund Burke, a stretched shift in – likely available - accompanying images and feelings. So: a stretched shift in 'context'.

*Back to our Architectural Design Studio Critics*
*There are three possibilities to react on our literary broad talented student:*
1. *A conscious restriction of the literary prose: the outcome of philosophic theory of Jacques Derrida is that in scientific use one has to secure the relation between text and context in more than one way.*
2. *A conscious and on purpose use of metaphors (words which have a very free relation between 'signifier' and 'signified' and evoke images and feelings) to stimulate creative processes (Segers, 2004).*
3. *A conscious and on purpose creation of pure cultural artistic literary prose, as thePhilosopher Edmund Burke stated.*

**ICT Developments and resulting trends**
With help from internet dictionaries and treasurers it is relatively simple to create rich texts with a lot of metaphors with gradual shifts in context, meaning, images and feeling.

With help of all kinds of Photoshop-programmes you can also use a kind of 'imaging metaphors' in your Architectural models and drawings as well.
With the help of the internet search machines as Google it almost seems possible to link all Theoretical Concepts to your Architectural Design. In random order you can randomize pro and contra arguments and compose them in an endless way.
Nowadays you can make a 'Gesamt Kunstwerk' with only a fraction on insight and scientific knowledge what was needed for it some 20 years ago: 'you can make a 'Gezamt Kunstwerk' on a lazy afternoon in summertime'

A PhD study named: 'Incorporating Cognitive/Learning Styles in a General-Purpose adaptive Hypermedia System' (Stash, 2007) confirms the relatively simplicity of that kind of use of internet search machines. The nowadays Adaptive Hypermedia give already user support true 'adaptive navigation support'(also called: 'link adaptation') as well as 'adaptive presentation'(also called: 'content adaptation'). The PhD study adds new possibilities for 'automatic customisation' of personal related cognitive styles, through the development of a meta-model for a corresponding computer language.

The social trends in using the benefits of the ICT-developments are also rapidly changing. Some 5 years ago it still was not done for a Scientific Researcher to make openly and extensive use of the internet search machines.
Now at the moment the majority of Researchers use the internet for research and for publishing. Thus creating a new Scientific Environment in a Methodological and Philosophic way.

Once again we can go to the Philosophic contributions of Edmund Burke and Jacques Derrida. And also to work of the American Philosopher and Art Critic Arthur Danto and his Theory about the Philosophic-Theoretical Ending of Arts (Danto, 1986).

Arthur Danto goes beyond the much-discussed proposition of the end of Avant-Garde and Modernism. He sees this as the end of a longer development: namely as the end of Philosophic-Theoretical Progress in Arts.
He distinguishes three models to describe the History of Arts.

The first model is Art as Representation of reality and the Historical-Theoretical development of an increasingly superior representation of the world. This ends with the rise of photo and film.
Danto sees the Abstract Arts as a blind alley and as no real solution in terms of continuous progress in arts.

The second model is Art as Expression. He sees this also as an escape route, because there is no 'Mediating Technology of Expression' and therefore also no continuous progress in Arts. There is no coherence and Art History is only a 'pack of cards'.

Danto's third model sees Art History as a kind of Philosophic-Theoretical Understanding. Autonomous concepts, comments, references and self-references rules over and Art becomes a synonym for Philosophy. Art becomes a statement of its own without any progress. Its accumulation is the Brillo Box of Andy Warhol (Danto 1992).

Danto marks the beginning of the End of Arts at the technological innovation of photo and film. Meant slight ironically, he sees it only as the Historic-Theoretical End of Arts. He states that Art, Art History and Art Critics will last for ever. It will give 'access to all' and it will be continued as a kind of hedonistic playing.

This fits exactly in the Philosophy of Edmund Burke, who stated that literary prose can produce pure meaningless cultural enjoyment.

Probably Danto could not realize that within a period of 15 years ICT-technology would develop so heavily that is also hits very hard in the sphere of Art Expression (meaning: imaging, feeling) and the sphere of Philosophical-Theoretical conceptual underpinning.
All of a sudden there is not only one but three technological innovations which mark Arthur Danto's End of Arts! (photo and film imaging, computer graphics photo and film manipulation and internet search machines).

The Google search machine would have created the ultimate nightmare for Jacques Derrida as well, or – on the contrary – it proves his being right ? The computer search machine automates the placing of all text outside its original context. More than ever there is room for a plea for multiple coupling between text and context. In this case: realistic working Design Paradigms, which couples design features and representation (meaning: image, feeling) in a multiple way.

**Demand for realistic working Design Paradigms**
The usual method for teaching Architectural Building Design in the first year of study is that of the Design Studio. It is a kind of Master Class Teaching, which can be described as a Black Box Approach. This Black Box nature disguises the lack of Methodology, Transparency and Continuity. The main effect of the Black Box nature tends that the most social intelligent student – who can guess the intentions of the Master as best – will be the best Design-student.

This Black Box Design Teaching ignores Cognitive Psychological Research on Professional Architects, what claims that there are quite different Professional Design Strategies, which depend on Personality Temperaments (Van Bakel, 1995).
Some Schools of Architecture deal with this problem by focusing on only one main Design Approach and only one main Design Strategy. So for the incoming students it can be clear what kind of Architectural Style they will be educated in.

Inside the pluralistic Dutch Architectural Design Schools several Design Approaches and several Design Strategies coexisting with each other at the same time inside one School. Inside those Pluralistic Architectural Design Schools teaching problems due to Multiple Design Approaches and Design Strategies became very apparent at the end of the 20th century, when Architecture was booming.

The PhD study 'Learning to Create' (Proveniers, 2005) provides a Core Strategy to facilitate the students creative voyage of discovery into several parallel Design Approaches and several Design Strategies.
It makes active use of realistic working 'Design Paradigms' in offering the students the facility to discover ones own – personality dependent – creative affinities and develop these as well.
These Design Paradigms are Design Principles related to specific effects, so as the asymmetrical balance propagated by the Dutch movement 'De Stijl'.
They are called Paradigms because they form a closed set of rules and that set of rules is competing with other – opposite – sets of rules. For example the asymmetrical balance of 'De Stijl' against the symmetrical balance of Palladio.
You have to make a choice: you can not follow both sets of rules in one Design. Also it is useless to deny one of those sets of rules.

In the 'Learning to Create Educational Strategy' Design Paradigms are translated to very open and broadly formulated Design Problems and scaffolding exercises. So students can become acquainted with and experiment with several Paradigms at the same time simultaneously.

**The new BaMa Structure**

As part of a management reorganisation the Eindhoven University of Technology in the Netherlands already started to implement the Bachelor Master System in the year 2000. So already some tendencies become evident.

Preceding the BaMa Structure the Department of Architecture and Building had a 5 year study programme in a relatively autonomous 'management surrounding'.

As part of the implementation of the BaMa Structure the National Government, National Pressure Groups and the Government of the University tends to tighten their grip on the Study Programmes and want to control 'supply and demand' of Study Programmes and student choices.
This seems to result in a kind of 'tsunami-effect'. First the withdrawal: there are less Bachelor Study Programmes than there were in the 5 year Programmes before. Then the flooding: there are far more Master Study Programmes than there were 5 year programmes before.
Universities and Schools of notion and standing may disappear in the flood wave of hundreds European small Master institutes, with also all kinds of Major and Minor variants.

Concerning the content of the Study Programmes there might be less educational connections between the new Bachelor Programme and the new Master Programmes (one Bachelor Pro-

gramme prepares for much more Master Programmes than before).
Concerning the Formal Juristic Entry Requirements there might be a lot more connections between one new Master Programme and all kind of Bachelor Programmes ('all' Bachelor programmes give access to the Architecture Master programme: so the start of the Master Programme has to be very basic).
This tends to a reduction of the actual instruction time for the Architecture Study Programme. Pure formal: only 2 years of Masters will rest.

This might let to all kinds of juristic very interesting cases in European Court. If you have formal access to a School on basis of a degree of several different Bachelors, than the School programme has to be 'doable' for a certain percentage of the students of those different Bachelors. If students need very specialised knowledge skills, which only can be learnt at a one and only particular Bachelor Programme, it will hinder the formal free access to that school. The perception of this problem will of course be different in the cultural different European countries.

An other possible Future Trend in the BaMa Structure could be an American infill of the BaMa: most students do only a three years Bachelors and only the most talented do directly a PhD and no Masters. The Masters is only an 'end-station' for the semi-talented. Because these Bachelors all have extended 'Minors' with relatively small 'Majors', a comparable situation will occur.

Reduction in actual instruction time for Architecture is in conflict with the Black Box Model in the Architectural Design Studio. The adage is that 'Architecture quality takes a lot of time'.
In the 5 year Programme a student could compensate the lack of Methodology, Transparency and Continuity of the Black Box Approach by choosing a particular Architectural Teaching Group with an own Design Approach and own Design Strategy at the end of the first year of study. So the student 'buys himself 4 years time' to learn the particular habits of the Architectural Teaching Group and so reach a certain quality level within these group standards.
In the new Master Programme there is less time left. So it is obvious that the teachers will observe 'a regression in Architectural quality amongst the youngest student generations' and the young Architects will be thrown back to their own capabilities more and more: their advantage of their sublime 'verbal en graphical use' off all kinds of ICT-extensions.

**A plea for a Third Approach: realistic working Design Paradigms, next to the two main lines of Architectural History and Architectural Theory**

As a likely and on some Theoretical en some Historic origins of Architecture oriented replay to the problems around ICT-technology and the new BaMa Structure, I plea for a Third Approach: realistic working Design Paradigms: Design Principles related to specific – 'researched' - effects.

The realistic working Design Paradigms could offer a concrete answer to the new occurrence of the Philosophy of the End of Arts from Arthur Danto, what new occurrence substantially gains strength through the possibilities of ICT-Technology - and simultaneously - the intensifying conflict between the actual reduction in instruction time for Architecture inside the BaMa Structure and the dominant Black Box Design Education Model.

Earlier formulated answers to the Philosophy of the End of Arts already vague indicated in the direction of a Cognitive Approach (Doorman, 1994, who refers to Gablik, 1976 and to Goodman, 1969).

The Third Approach of realistic working Design Paradigms is no substitute for the two main lines of Architectural History and Architectural Theory.
Also, the paradigms are no 'Closed Architectural System' (as were developed in the sixties and seventies) but can include all possible opposite concepts.
Also the specific effects which the Design Rule (ought to) have on the users are included and also the learning effect on the Designer Community (the Cognitive Character of the Paradigms).
That is why they are characterized as Paradigms: relatively closed sets of rules including their specific effects, which are conflicting with other sets of rules and their specific effects.

**Young Architects: 'Children of their Time'**
Arthur Danto foresees in his End of Arts only a Philosophic-Theoretical End of Arts. Not the End of Arts as such. Quite the reverse: there will be 'access for all' and it will grow to the configuration of a hedonistic play. As I – metaphorical – described it as: 'the making of a 'Gezamt Kunstwerk' on a lazy afternoon in summertime'

In his well-known book: 'the Rise of the Creative Class; and how it is transforming work, leisure, community and everyday live' Richard Florida refers to the new Creative Class which combines a hard working labour ethos with a pleasure seeking hedonistic life fulfilment.
Other, more Scientific Human Researchers say that nowadays youth have only weak bonds to a field of study and will see it as a challenge to continually prove themselves in new domains (Bras-Klapwijk, 2005).
In terms of the famous Human Career and Organisation Expert Edgar Schein, nowadays youth has much weaker carrier anchors than older generations. They are more extravert and want to work on their own multi-personality growth (Bras-Klapwijk, 2005). Not as a kind of mental sickness (no multi personality syndrome). Not as a kind of provocation like the Avant-Garde from the days before. But pure as a form of Creative Expression. Due to this they are more pragmatic - and have to be to reach their goals – then the older generations which had more confidence in Theoretical and Philosophical Dogma's and Ideologies. So they will be less interested in heavy Philosophical-Theoretical Architectural History and Theory.

*Back to our student:*

*He does not only look alike the New Hedonistic Creative Generation of Richard Florida and more scientific counterparts, he is the New Hedonistic Creative Generation: Using photo, film, computer graphics, Google and ICT.*

*The Design is totally build up out of metaphors. And as Edmund Burke stated: all to create feelings without meaning:*

- *Metaphorical drawing techniques.*
- *Metaphorical use of scale and materials for models (not to represent but to affect).*
- *Metaphorical use of colouring, imaging and lighting, possible through ICT.*
- *Metaphorical pseudo-Philosophical-Theoretical Concepts, made by the Google search machine.*

*Architectural History and Theory can not deny these trends and (international) design competitions are flooded with it.*

*We should make a separate category of it, next to the three Arthur Danto categories: Archi-Formance (as a contraction from Architecture and Performance). So we can give it a separate critique and a separate note and do the strictly necessary research on it .*

*Next to it, it is useful to try to look through the Metaphoric Design and give separate critiques to the more meaningful aspects of the Design related to Architectural Design Paradigms grounded in Architectural History and Theory.*

- *The power and force of attraction of the Poetry;*
- *The Multi-Paradigm character of Architecture;*
- *The gigantic opportunities of ICT;*

*bring along site the responsibilities to act and to create a 'base-line', in order that the 'Fleets of Architecture' do not strand on the cliffs of the unbridled use of verbal, graphic and theoretical metaphors, while attracted to the new Sirens of the Odyssey : Google, Hypermedia and Computer Graphics.*

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#A2

# #A3

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# Architectural User Interface: Towards a Performative Architecture

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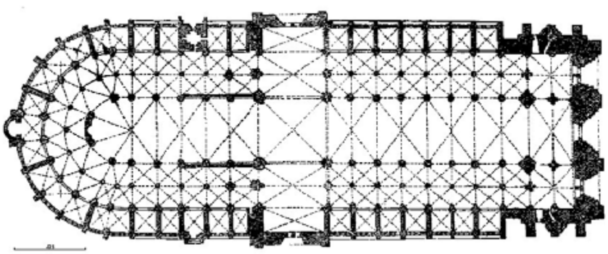
# Architectural User Interface: Towards a Performative Architecture



Notre Dame, plan

## I

*"This will kill that. The book will kill the edifice."* [1]

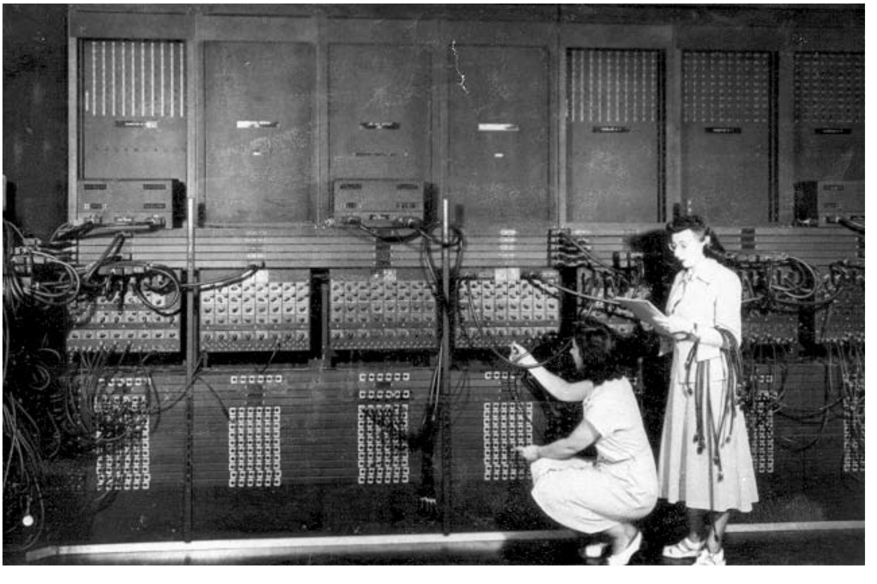
This is our primary question: with the inexorable advance of digital technologies along all fronts of human endeavor, whither architecture?

We identify *performance* as the primary criterion to revealing a new paradigm for architecture. We do not delimit this definition to the role traditionally played by mechanical and quasi-mechanical technologies in the optimization of environmental control systems and building skins. Nor do we intend to ascribe to performance the interpretation narrowly defined by the emergence of digital gadgetry, primarily optical in methodology, which have nonetheless already radically altered the means by which we negotiate our environment, built and otherwise.

Instead, we seek to engage a notion of *performance* that encompasses these definitions in a wider arc: one that seeks an understanding of a broad interface between architecture and technology, and one that attempts to solicit optimal collateral advantage from their respective strengths. From architecture, we affirm *presence* as its quintessential condition, its inalienable concreteness, with the necessarily contingent properties of Benjamin's 'tactile appropriation'. And from technology, we recognize the emergence of models of interactivity and intelligence that allow for not only new possibilities for the inhabitation and manipulation of space, but for indications of a new definition of architecture itself.

Epitomized by Hugo's observation, technology has long been portrayed as *adversary,* heedlessly overthrowing established cultural mechanisms with new modalities. Hugo's archdeacon divines in the printing press not only the loss of doctrinal hegemony by the Church, but by extension, the very stones of that institution itself: From the loss of the didactic monopoly of the inscribed monument and the illustrated cathedral, engendered by the rise of the printed word, comes the displacement of architecture's (implied) historical centrality towards the margins of cultural discourse.

Hugo's contemporary, Viollet-le-Duc[2], simultaneously identified in technology its potential role as *saviour,* believing it to be the means by which architecture might return to its former exalted stature, epitomized for him by the gothic cathedral. Viollet-le-Duc proposed an architecture freed from issues of 'style' and based upon a rational foundation of tectonics and materials science, and as such was instrumental in establishing a post-Enlightenment view of architecture, and design in general, that has sought to privilege performance (measurable, empirical) over aesthetics (subjective, idiosyncratic). His ecstatic vision for the emancipating role of technology morphed long ago into the breathless genre of futurology, exemplified in the pages of *Popular Mechanics* and, more recently, *Wired* magazine.



**ENIAC Programming,U of Pennsylvania**

## II

*"The fathers of the field had been pretty confusing: John von Neumann speculated about computers and the human brain in analogies sufficiently wild to be worthy of a medieval thinker, and Alan Turing thought about criteria to settle the question of whether machines can think, a question of which we now know that it is about as relevant as the question of whether submarines can swim."*[3]

It is a commonplace that the recent history of technology has been marked by the rapid expansion of the scope, both conceptually and literally, of the integration of computers into our lives.[4] We all know that computers are in our cars, our watches, our toasters, our cell phones, and virtually everywhere else.

The near ubiquity of digital processors brings with it a defining design challenge of our era: that of the interface between computer and operator. Beyond the punch-card and DOS-based keyboard models that characterize the natal stage of digital technology, the emergence of the GUI(Graphic User Interface), first developed in the '70s at the Xerox Palo Alto Research Center, currently defines the essential paradigm for digital interactivity. More advanced models are presently under development, including the Tangible User Interface(TUI): the interface theorized by researchers at the Media Lab at MIT[5] that extends the computer beyond the monitor into other forms that can be touched and manipulated. In addition, techniques such as CavePainting have been explored that use virtual reality techniques to make three-dimensional paintings[6].

These efforts within computer science represent, if not a challenge, certainly a poaching of architecture's physical and conceptual turf. Each specifically appropriates traditional elements of architecture (surfaces, volumes, spatial hierarchies). As this work progresses inexorably, it is fair, indeed necessary, to ask what remains essential to architecture?

## III

*"…the tasks which face the human apparatus of perception at the turning points of history cannot be solved by optical means, that is, by contemplation, alone. They are mastered gradually by habit, under the guidance of tactile appropriation."*[7]

Architectural User Interface is an operational metaphor to an architecture that might exist if we think of the computer not as a means of representation, but as embedded with-in the media of architecture itself.

The first question that arises from such an investigation is the nature of the media itself. In any interface, the physical and ergonomic nature of either the punch card and the teletype or the mouse and the screen establish a particular relationship with the user, a presence that has grown more involving as immersive technologies have developed.

Architecture's irreducible presence is its engagement of all our senses. We do not make an argument for a phenomenological approach, but rather recognize the manner in which architecture inevitably engages our senses of sound, tactility and smell as surely as it does our sight. This physical presence and the digital interface are two separate yet complementary aspects of any architectural interface.

**IV**

*"A picture is worth a thousand words. An interface is worth a thousand pictures."*[8]

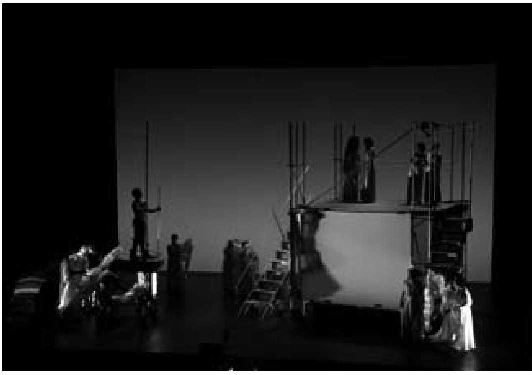
Interface design has developed by trial and error, gradually assembling provisional rules of thumb. For example Ben Schneiderman's "Eight Golden Rules"[9] (consistency, shortcuts, feedback, sequences, error handling, easy reversal, internal locus of control and reduce memory load) are an inductively derived set of principles assembled from graphic design, communications and hardware limitations.

Among these principles of interface design, several are clearly applicable to architecture. Indeed, with the principles of consistency, sequences and easy reversal, it is tempting to speculate on the degree of influence that the shared experience and navigation of traditional built space has had on developers of digital interfaces: the metaphor of urban space has been used in computer science to help organize complex data.[10]

One principle among these that is foreign to architecture as currently practiced is feedback. An environment responding directly to its user is likely to transform our idea of architecture.

Feedback is related to architectural programming, behavior studies and all its variants within architectural thought. But the predominant idea of the human use of building is that it generates a fixed set of requirements, which a sensitive architect will be able to use as the starting point for design.  At best, this results in work by architects such as Van Eyck and Herzberger that propose an open-ended provocation of human occupation. Post occupancy evaluations are the only (pathetic) example of architectural feedback. We demand an on-going recursive participation of the user over time.

The focus of our work, then, is to make the building responsive, to see the performance of the user as an integrated part of the building. A performative architecture will have the user become a central part of the experience in a way that modernist thought, absorbed as it was with function, could embrace in only a desiccated form. But just as Hugo warns us about the triumph of the printed word and widespread literacy turning into a second Tower of Babel, the diffuse user "input" of performative architecture has its dangers. Precisely to the extent that it is responsive, it is unpredictable in ways that are unaccustomed and almost certainly uncomfortable for architects; the myth of the master builder will be difficult to sustain in such an environment. At best,



Dido & Aeneas, Henry Purcell, Opera Workshop

Gutenberg Bible

we may be able to embrace the idea of narrative, but there will be so many narratives, and our pleas for authority may be unnoticed.

This proliferation of narrative engagements will lead to an issue of framing. Lacking the clear mechanisms of the literal picture frame and the metaphorical frame of the museum, architects have almost always relied on geometry to call attention to their art; it is "here" and not "there" that you should look. Whether this takes the form a simple and reductive form (Palladio and Eisenman) or a loosely composed grouping set apart from the context (Gehry) or a set of particular and idiosyncratic gestures (Libeskind), we have no problem identifying the limits for our attention. But a truly *performative* architecture must disdain these limits, and accompany the user into overlapping and loosely defined environments.

**V**

*"Interactive media do not sap the spontaneity or variability from a live performance, as linear media do, since they embody those qualities. Media are interactive to the extent that they adapt to the performer rather than making the performer adapt to them. By definition, the more interactive the media, the more responsive. Theatre that incorporates interactive media has the potential to combine the strengths of both live performance and media."*[11]

The primary venue for our research in performative architecture is theatre and opera.  These endeavors enjoy a tradition of human interaction that is more focused, time-based and articulated than a general architectural practice.

One advantage of such venues is the existing tradition of liveness in theatre, and which define practices that align themselves with our research preoccupations with interactivity. Interactive media can be invented and explored to extend this idea in a controlled setting.

In theatrical settings, electronic interactivity has both a traditional theatrical meaning and a potential to destabilize and expand the theatre setting. Interactivity defines an essential characteristic of theatrical performance; actors making asides to the audience, entering from the house to the stage, and performances that physically engage the audience demonstrate aspects of the fundamental liveness of theatre. Computers offer a way to extend the reach and character of this interactivity, but ironically only to the extent that they clearly reveal their character as artificial. Computers can force the audience to be aware that it is watching a play, and create critical distance from the action; Bertholt Brecht describes this as *Verfremdungseffekt*, or "estrangement effect".[12]

Another advantage, particularly in early stages of development, is the fact that the users are more expert at using what are often systems that are initially less than robust.  Just as a line in the score may be awkward and a costume change may come at inconvenient moment, actors are more agile in their adaptation to unconventional participants.  They can find ways to avoid a particular position in a motion capture suit the same way they learn not to make a particular move for fear they may tear their costume.

The collaboration of the Opera Workshop and the Digital Design Center at UNC Charlotte is a laboratory for the development of performative architecture. We have collaborated on performances of Dido and Aeneas by Henry Purcell and *Les Arts Flousissants* by Marc-Antoine Charpentier .

During the staging of these operas, we used video and sound capture, motion capture suits, real time compositing and a variety of other technical devices. But our focus was not on the technical aspect, but rather on the transformative aspects of the technology.

Our work had lead us to recognize three realms of presence: the presence of time, the presence of material and the presence of experience.

The presence of time arises from any form of interactivity.  As the computer is incorporated into the stage, it connects actions on the stage with reactions from the setting in new, more immediate ways.  This has been accomplished using video and audio feedback mechanisms, motion capture suits driving avatars and through motion controlled sound systems.  The immediacy of real-time effects heighten the interaction of the actors with their control systems.  Timing is everything and the reaction of the entire troupe to a misstep or to a misguided wii-mote, renders their characters more human, despite the very unreal nature of their mistakes.

The presence of material has contrasted the virtual and the tangible aspects of the stage design. Our design have emphasized the physical presence of the stage sets though large scale rolling scaffolding and elaborately fabricated sets that have a physical presence that sharply contrasts with the virtual devices and effects. The visceral sound of the rolling stage is made evident by the artificial layering of images and projections. The physical objects become surfaces, which are both seeing and being seen. They are the devices for interpreting the actor's moves and for redisplaying their altered states.

The presence of experience serves to allow the "spectactor"[13] to be seen as both a character and a human actor. Clifford Geertz has called this effect "experience near" and "experience distant"[14] and identifies it as the critical skill needed to understand other people in a cultural setting. We have done this by making clear the mechanisms by which the opera are made to work. We reveal the projectors, the computers and the operators who cause the altered reality. These objects are placed in the theater in ways that make them as much a part of the performance as any one audience member or any one actor. The technology occupies the most prominent places backstage, onstage and in the best box seats of the theater. Speakers for real-time panning are even placed in the theater to sing back at the singers, under their control on stage, of course.

**.....n**

*"The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are undistinguishable from it."*[15]

*"All that is solid melts into air, all that is holy is profaned, and man is at last compelled to face with sober senses his real conditions of life………..."*[16]

We cannot yet clearly see the unborn child of architecture provoked by the onslaught on the digital. But perhaps we can begin to see an outline.

The Architectural User Interface will be a combination of the tangible and the virtual. Rather than proposing either that all intellect will become silicon based or that computers are essentially useless, it will make a new setting that takes advantage of the strengths of both.[17]

The Architectural User Interface will be defined not by geometry but by topology, which insists that the essential character of a problem is in the sets of relationships rather that in a singular form. It will probably doom most of the formal conventions of architecture, certainly as they are used to en-frame and limit a specific object.1[8]

Finally, and primarily, the Architectural User Interface is defined by interactivity with the user, through a specific and sustained performance. This is a disquieting situation for architects who by training and reflex view the world quietly and synchronically. But, it is precisely this aspect of the digital that can force us to see the world with fresh eyes and to cast aside preconceptions masquerading as the natural.[19]

The extent and outline of cultural practices are not invariant. Even for what Benjamin characterizes as its uniquely "uninterrupted" presence among the arts throughout history, the practice of building has demonstrated a parallel fluidity in its very definition. Etymologies for the term *architecture* itself reach no further back than the mid-sixteenth century, and most definitions of it that we would recognize derive from post-Enlightenment discourse: this is very recent indeed. The *degree* to which technology is instrumental in the mutability of contemporary cultural practices suggests its *immanence* within a new definition of architecture, while the rate of change wrought by technology suggests the *imminence* of such a paradigm.

Architecture is dead; long live architecture.

## Notes

1. Victor Hugo, *The Hunchback of Notre Dame*. (Croscup & Sterling: New York, 1892). Hugo intends at least two meanings for this comment, one related to the lose of authority for the church to the individual and ultimately secular concerns and another related to the end of architecture as the sole repository of concretized culture.
2. Viollet-le-Duc's hope for the role of technology as savior is focused mainly on the restoration of historic monuments, ironically enough, largely in Gothic structures that Hugo cites for their anachronistic quality. Eugène-Emmanuel Viollet-le-Duc, *The Foundations of Architecture*, (George Braziller: New York, 1990).
3. Professor Edsger Dijkstra, Lecture delivered at the ACM 1984 *South Central Regional Conference*, Austin, Texas, 16 to 18 November 1984. The common preoccupation with the inferred anthropomorphic dimension of computing continues as a thinly veiled apotheosis of fear. It is interesting that the "worms" and "viruses" that are significant agents of mischief are specifically human sponsored.
4. Paul Douish, in *Where the Action Is: The Foundations of Embodied Interactions* (MIT Press: Cambridge, Massachusetts, 2001) traces the development of four modes of interaction (electrical, symbolic, textural and graphical) and presents an argument for reconceptualising the idea of HCI around embodied interaction. Our argument accepts his framework but we will try to make a specific case ofr the role of architecture.
5. Hiroshi Ishii and Tangible Media Group, *Tangible Bits: Towards Seamless Interface between People, Bits, and Atoms,* (NTT Publishing Co., Ltd.: Tokyo, Japan, June 2000). The work of the tangible bits group at the MIT Media Lab has consistently connected physical objects and environments with computers. This work is notable for its early success as well as its insistence on the inclusion of both the computer as active elements in the design.
6. Daniel Keefe, Daniel Acevedo, Tomer Moscovich, David H. Laidlaw, and Joseph LaViola, "CavePainting: A Fully Immersive 3D Artistic Medium and Interactive Experience", *Proceedings of ACM Symposium on Interactive 3D Graphics,* (Association of Computing Machinery: New York, 2001) pages 85-93. Caves are an extreme example of immersion, combining a three-dimension model, gestures, tracking and see through head mounted displays. The combined effect is a three-dimension model that can be navigated and manipulated in real time.
7. Walter Benjamin, "The Work of Art in the Age of Mechanical Reproduction", *Illuminations* (Schocken:New York, 1969). Benjamin is very specific in specifying architecture as a canonical example of an art that is seen in a distracted manner. It is fair to infer that the distraction has increased as the extent and the nature of media have proliferated.

8. Ben Bederson & Ben Shneiderman, *The Craft of Information Visualization: Readings and Reflections* (Morgan Kaufmann: San Francisco, 2003)
9. "Eight Golden Rules" are one of a number of lists, recipes and rules of thumb that Shneiderman assembles in this book. Much of this will strike those with a visual and design training as common sense mixed with a dollop of appreciation for the novel effect of the computer. Ben Schneiderman, *Designing the User Interface, Strategies for Effective Human Computer Interaction* (Addison-Wesley, Reading, MA, 1977).
10. See for example, Ruth Dalton's article "Is spatial Intelligibility Critical to the Design of Large Scale Virtual Environments?" in *Journal of Design Computing 4, Special Issue on Designing Virtual Worlds*, 2002. Dalton makes the argument that the use of ideas of urban legibility as a metaphorical framework allows users to understand very large data bases more effectively than other methods.
11. David Saltz, "Live Media: Interactive Technology and Theatre." *Theatre Topics* 11.2 (Fall 2001): 107-130. Saltz presents a convincing argument about the role of digital media in traditional theatre settings, including a taxonomy of the possibilities for further explorations.
12. Bertholt Brecht was determined not to let the audience be seduced by the "natural", but instead to be led to understand the artificiality of both theatre and by implication, current cultural conditions. According to Brecht, an actor "..never acts as if there were a fourth wall besides the three surrounding him..... The audience can no longer have the illusion of being the unseen spectator at an event which is really taking place." Bertholt Brecht, *Brecht on Theater: the Development of an Aesthetic* (Hill and Wang: New York, 1964) page 91.
13. Brazilian dramatist Augusto Boal extended Brecht's ideas, creating the Theater of the Oppressed". His combination of the actor and the spectator into a "spectactor" is his attempt erase the critical distance in conventional theatre as well as engage the participants in the substructure of the theater. His work includes *Games for Actors and Non-Actors* (London: Routledge, 1992) and Theatre of the Oppressed (New York: TCG, 1985)
14. Clifford Geertz article "From the Native's Point of View" in *Local Knowledge: Further Essays in Interpretive Anthropology* (Basic Books, 1983) seeks to provide a foundation for the way in which anthropologists can understand a culture which is not their own. He rejects simplistic ideas of empathy, instead calling on hermeneutics to provide a dual understanding of the world, one based on "experience near" immersion in a situation and the other on "experience far" understanding based on objective criteria and evaluation. He makes a claim for the necessity of both if we are to understand the "other".
15. Mark Weiser, "The Computer for the Twenty First Century", *ACM SIGMOBILE Mobile Computing and Communications Review* (Volume 3 , Issue 3, July 1999). There is a long tradition in the history of ideas that identifies the invisibility of a good deal of modern existence. (See, for example, Suzanne Langer's Philosophy in a New Key.) Weiser, however, seems intent on embracing it as a positive condition.
16. Karl Marx and Frederick Engels, *Communist Manifesto (Monthly Review Press: New York, 1998).* Marx and Engels intend this as a prelude to the economic enlightenment of the proletariat, but it is difficult not to read it as a more general description of the transformation of the cultural to the natural.
17. One parallel example of this is the work of Luis von Ahn and his idea of human computing. His very specific methods of combining the strength of human cognition with machine processing proposes a new paradigm for computing that avoids polemical position about either human or machine cognition. Luis von Ahn. "Human Computation." Google Talk, July 26, 2007. http://video.google.com/videoplay?docid=8246463980976635143&q=von+ahn&total=16&start=0&num=10&so=0&type=search&plindex=0.
18. One of the clearest examples of a theoretician moving toward this position is the work of Stan Allen, notably in his book, *Point + Lines: Diagrams and Projects for the City.* The projects presented in this book are as uncomfortable fitting on the pages of the book as it would be to identify them within the context of the city. Stan Allen, *Point + Lines: Diagrams and Projects for the City* (Princeton Architectural Press: New York, 1999).
19. Our challenge is similar to that identified by Banham when he notes that "The architect who proposes to run with technology knows now that he will be in fast company, and that, in order to keep up, he may have to emulate the Futurists and discard his whole cultural load, including the garments by which he is recognized as an architect." Reyner Banham, *Theory and Design in the First Machine Age,* (Praeger: New York, 1960).

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# Situated Technologies

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# Situated Technologies

**Abstract**
Architecture's privileged position as the technology of space-making is challenged by the current proliferation of a wide range of mobile, embedded, networked and distributed media, communication and information systems. Our interactions with (and through) these location-based, context-aware and otherwise "situated" technologies are beginning to alter the way we perceive, navigate and socialize within the built environment. Prompting a reconfiguration of material boundaries, organizational adjacencies, and public/private relations, these technologies (and the ways in which we engage them) have significant implications for how we conceive, design and experience space. In this paper, we identify three vectors for architectural research that explore the spatial opportunities presented by what we call Situated Technologies. Working across the overlapping boundaries of media, architecture and computing, this research attempts to articulate how architects might play a critical role in shaping evolving techno-social spaces increasingly governed by both material and immaterial processes. As *exploratory* research, it aims less to propose solutions to known problems than to arrive at precise questions that help us better identify and structure new problems for architecture presented by recent developments in ubiquitous/pervasive computing.

**Introduction**
Mark Weiser begins his seminal 1991 paper on ubiquitous computing titled, "The Computer for the 21st Century," by suggesting that "The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it" (Weiser, 1991). With respect to ubiquitous/pervasive computing, this is literally true. As computing leaves the desktop screen and spills out into the world around us, information processing capacity becomes physically embedded into everyday artifacts, materials and spaces. Perhaps more profoundly, Weiser imagines this "disappearance" as constituting an ever-present instrumentality available to us wherever we go, remaining at the periphery of our awareness. Drawing a comparison with a walk in the woods, he contends "There is more available at our fingertips during a walk in the woods than in any computer system, yet people find a walk among trees relaxing and computers frustrating. Machines that fit the human environment, instead of forcing humans to enter theirs, will make using a computer as refreshing as taking a walk in the woods." Through this simple analogy, Weiser projects a future where the computer and computing dissolve into the environment. What are the implications for architecture of computing becoming environmental? How will this transformation influence the way we conceive, design and construct space?

In the passages that follow, we outline three research vectors that arise when architecture engages the affordances of ubiquitous/pervasive computing. The first concerns the (re)contextualization of information as it moves from atoms to bits and back again, making possible new forms of agency for networked artifacts, materials and spaces. The next addresses the changing nature of computer assisted design with the shift from representational problems to performative ones. Here a preoccupation with modeling reality gives way to allowing reality to become a model of itself. Finally, we consider how ”situating” these technologies in terms of action and activity opens architecture up to an expanded range of material and immaterial ”events” that take place within it. Rather than considering material artifacts as the sole means for organizing space, architecture is enabled to engage other spatial ”actants” (Latour, 1992) including people, networks and information flows in shaping the experience of the built environment.

**From Atoms to Bits (and back again)**

If atoms are the basic unit of the physical world, then bits are that of the infosphere. From the Chinese abacus, to Jacquard’s loom, to Hollerith’s tabulators, to the Turing machine, Vannevar Bush’s ”Memex”, the pocket calculator and the modern PC, the history of computing can be read as a series of increasing levels of abstraction from the world of atoms to that of bits. From encoding weaving patterns in punch cards to the development of autonomous agents exhibiting properties of intelligent life-forms, information has increasingly lost its body (Hayles, 1999) and the physical world has become subject to forms of symbolic manipulation that afford ever greater degrees of automation.

With the dawning age of ubiquitous/pervasive computing upon us, however, we find a turn in the other direction. This linear progression from atoms to bits is reversed, with bits moving back into an ”embodied” world of atoms through mobile and embedded computing. Dichotomies of analog/digital, actual/virtual, material/immaterial dissolve in favor of a dialogue between them. No longer content to remain in the realm of symbols, ubiquitous/pervasive computing involves sensing the world, deliberating about it, and subsequently responding to it through material and immaterial means.

This shift is primarily enabled by two technological developments: the continued miniaturization of microprocessors and the development of low-power wireless networking. These technologies contribute to the development of embedded sensor networks (Motes, EmNets) that are locationally aware, reconfigurable and adaptable to changing environmental conditions (CNSEC, 2001). The miniaturization of the integrated circuit has made it possible to embed information processing capacity into devices that would otherwise not be considered “computers”: microwave ovens, cell phones, cars, clothing, as well as traditional components of architecture such as windows, doors, walls, floors, roofs, facades and so on. Along with this miniaturization, the computational performance of these circuits has increased while the cost of their production and power consumption has decreased.

Likewise communication technologies, both wireline and wireless, have improved considerably. Land line fiber optic cables provide greater signal capacity through a process called wavelength-division multiplexing in which different colors in the optical spectrum are used to multiply the communication channels. At the same time wireless technologies have had to grapple with the scarce resource of the radio frequency spectrum resulting in short range wireless systems like wireless Ethernet or WiFi (IEEE 802.11 standard) and Bluetooth, which replaces cables and allows devices to talk to each other at short range. By spatially sequestering such communication networks, robust communication can be maintained. However, their application within larger geographies requires their ability to scale. To address this, Multi-hop Wireless Mesh Networking has been introduced to enable network data packets to be routed through intermediate network nodes over greater distances. In turn, this enables the communication spectrum to be divided up so that computational devices can take turns using it. This allows multiple devices to communicate through different parts of the spectrum (from infrared to radio) while also sharing information through data aggregation collaboratively processed at intermediate nodes.

The implementation of these technologies suggest a different topology than that of existing electronic networks. On the Internet, spatial location is to a large extent inconsequential. With situated networks, proximity becomes critical. Their limited range not only requires them to search out proximate devices to relay information across the network but also enables them to operate under lower power conditions. This emerging topology of embedded networks reinserts the local into the global informational network, and enables networked “things” to perform relative to the specific conditions of their location and context. Artifacts, materials and spaces that autonomously access and share information become possible, making them not only producers but also consumers of that information.

Bruno Latour’s description of “actants” that perform chains of “competences and actions” in a specific setting is a useful way to think about these networked ”things” (Latour, 1992). Responsibilities are delegated to them, as with more mundane objects like automatic door openers and speed bumps, for example. Yet when these ”things” are capable of altering their programmatic configuration and developing others–both through interactions with each other and with their environment–new forms of agency emerge. The emergent ”sociality” of such non-human actants has profound implications for the types of spaces that we can imagine. Architecture becomes capable of engaging material, human and informational activity, making it potentially more responsive to the changing context(s) of its use and the environment within which it is situated.

**From Tools to Environments: Simulation vs Emulation**

To date, architecture has predominately engaged the computer as a tool. Simple uses include drawing, modeling, rendering and animating design propositions. More advanced applications include the study of algorithmic form and complex systems. Drawing on evolutionary principles, today’s use of modeling applications has led to a renewed interest in genetic algorithms, enabling programs to ‘learn’ and adapt themselves to changing conditions. With embedded computing, however, new opportunities emerge for the design of buildings and spaces capable of responding to evolving events and activity within them. Here, the computer becomes less a tool for simulating evolutionary design, and more a medium for enabling buildings and spaces to evolve in the built environment.

Computer aided design has been preoccupied with representational problems since its beginnings with Ivan Sutherland's Sketchpad system of 1963. The pursuit of drawing and manipulating geometries has since led to more sophisticated computing tools that provide increased control for representing, visualizing and simulating reality. In all of these cases the screen has remained the interface for interacting with information while the computer's memory has been the source and generator for all displays of the data. However, when computational technologies are distributed into the materials of the spaces we inhabit, their situatedness provides a more complex relationship with information. Not only does the nature of the interface change but perhaps more importantly the generative capability of information. This inspires alternative forms of interaction in response to the contingencies and provocations of the lived environment.

It is important to distinguish computing from more traditional tools in order to understand why representation has been their focus. Woolgar (1987) suggests that for prosthetic tools (hammers and their like) the "extensions" of humans is limited to the mechanical abilities of the body, whereas computing "emulates action and performance previously accredited to unique human intellectual abilities." Computing and more specifically artificial intelligence (AI) invokes an extension or mirroring of our thinking, reasoning and decision-making capabilities. In the early years of computing research this potential was the basis for contemplating an entirely different set of tools. Negroponte's formulation for an Architecture Machine (1970) is one of the most coherent attempts at bringing out the reasoning capabilities of the computer for design. The architecture machine would "converse" with the designer of whom it had a precise predictive model such that it could read his/her gestures and body language. It "would be so personal that you would not be able to use someone else's machine… The dialogue would be so intimate - even exclusive - that only mutual persuasion and compromise would bring about ideas, ideas unrealizable by either conversant alone. No doubt, in such a symbiosis it would not be solely the human designer who would decide when the machine is relevant." [Negroponte, 1970, p.13] Such a machine would not simply be a means to carry out the designer's will but potentially capable of exerting its own into the mix. While the prototype of Negroponte's machine remains elusive it nonetheless spurred a particular way of thinking about design and how computing could assist in the process. A key concept in this was that in order for computers to reason about the world they had to be able to represent it. It also suggested that these representations needed to be our representations.

Mitchell, writing in 1977 about computer-aided design, suggests ways in which computing can become a means for reasoning about representations:

"it is useful to regard architectural design as a special kind of problem-solving process and to discuss design within the framework of a general theory of problem-solving… It assumes that we can construct some kind of a representation of the system that interests us, and that problem-solving can be characterized as a process of searching through alternate states of the representation in order to discover a state that meets certain specified criteria." (Mitchell, 1977, p.27)

The computer's "intellectual" contribution to design would be as a "generative system", able to present the designer with alternative solutions to problems of her/his definition. Here architectural problem-solving is understood as "problem worrying" (Anderson 1966) and designing as "puzzle-making" (Van der Ryn 1966, Archea 1987) such that the computer is a means to explore different heuristics. This is done by generating through combinatorial and parametric variations different designs which are then evaluated by the designer or the computer. Mitchell argues that representations built by the designer in the computer can give "special insights into a problem, and significantly aid the process of solution generation. For example, representation in terms of some particular mathematical formalism allows known theorems associated with the formalism to be exploited in the design process, while representation by means of orthographic projections facilitates understanding spatial relations" (p. 38). Fast forward to our contemporary condition and the basic premise remains the same. However, now more sophisticated "hi-resolution" representations allow for evaluative criteria like structure, lighting, acoustics and airflow to be tested. Performance is invoked to suggest that a variety of quantifiable and qualifiable measures can be assessed from these generated solutions. While provocative, it is noted that more variety including "low resolution" representations are required in order to provide "a 'self-reflexive' discourse in which graphics actively shape the designer's thinking process" (Kolarevic 2005, p. 200).

While not dismissing the potential for design offered by such tools, Situated Technologies provide a different paradigm for computing and design. This rests on a shift from representing environments to performing (in) environments. Rather than trying to simulate the world, Situated Technologies use the world itself as a model. Computational intelligence is not employed to develop and sustain representations but to facilitate the performance of computational artifacts in context. Rodney Brooks in "Intelligence without representation" takes up this position to argue against representations as a basis for designing AI systems:

"The fundamental decomposition of the intelligent system is not into independent information processing units which must interface with each other via representations. Instead, the intelligent system is decomposed into independent and parallel activity producers which all interface directly to the world through perception and action, rather than interface to each other particularly much. The notions of central and peripheral systems evaporate. Everything is both central and peripheral." (p.149)

Brooks rejects the idea of needing a shared representation from which to work. He points to the fact that it is people that construct representations in computers and to assume that the perceptual world (Merkwelt) we provide is anything like the one we actually internally use is not clear. In fact it may be that our representations are more a means to communicate our perceptions with each other rather than how we actually perceive. For the machine to reason it must develop its own cognitions of the world which our computing systems are unable to because “the problems of recognition, spatial understanding, dealing with sensor noise, partial models etc. are all ignored. These problems are relegated to the realm of input black boxes. Psychophysical evidence suggests they are all intimately tied up with the representation of the world used by an intelligent system” (p.143). Shunning a centralized approach wherein a perception module delivers a representation of the world to a central intelligence which processes that information and then has an action module carry it out, Brooks suggests a decentralized system wherein activity becomes the means to divide up the intelligent system. Such a “behavior producing system individually connects sensing to action… The advantage of this approach is that it gives an incremental path from very simple systems to complex autonomous intelligent agents. At each step of the way it is only necessary to build one small piece and interface it to an existing, working, complete intelligence” (p. 146-7). In contrast, he argues that decomposing a centralized system requires “a long chain of modules to connect perception to action.” By doing away with representation altogether Brooks presents a model of intelligence that is contingent on the world that it interacts with and is emergent: “There are no rules which need to be selected through pattern matching. There are no choices to be made. To a large extent the state of the world determines the action of the Creature. [Herbert] Simon noted that the complexity of behavior of a system was not necessarily inherent in the complexity of the creature, but perhaps in the complexity of the environment” (p. 149).

Situated Technologies shift the locus of our attention from the capability of individual tools to the networked behavior of multiple systems in the environment. Computationally augmented objects, “emulators” as opposed to simulators, provide a glimpse into the possibilities that such technologies might have as they become pervasive.

Two contrasting examples are the in-flight simulator and the Re-performance®.
In-flight simulators are aircraft augmentation technologies that alter the actual flying characteristics of a plane. They are used as training environments that can make the augmented planes perform like another plane. One application is the “Upset Recovery Training” program:
“The simulation computers of the Learjet are programmed to produce responses that simulate actual aircraft upsets that have resulted in accidents. These upsets include wake turbulence, icing, trim run-aways, control jams, CG shifts, engine failures and hydraulic failures. Real aircraft accelerations and actual out-the-window visuals produce pilot stresses that are hypothesized to result in a level of training that ground-based simulators can not achieve.” (p. 11)

Similarly, Re-performance® is a registered trademark of Zenph Studios famous for their “re-performance” of Glenn Gould’s 1955 recording of Bach’s Goldberg Variations. Zenph produces software that contains “every detail of how every note in the composition was played, including pedal actions, volume, and articulations – all with millisecond timings. These re-performance files can then be played back on a real acoustic piano fitted with sophisticated computers and hardware, letting the listener “sit in the room” as if he or she were there when the original recording was made. Most importantly, the re-performance can be recorded afresh, using the latest microphones and recording techniques, to modernize monophonic or poor-quality recordings of beloved performances.” (http://zenph.com/reperformance.html) In both cases the complexity of the environment isn’t modeled but engaged such that heightened emotional response and open interactions are made possible.

**From Objects to Events: Typological vs. Topological Form**

Typology in architecture is invested in the idealization of form, involving taxonomic classification of characteristics common to groups of buildings including shape, organization of parts, construction, symbolic meaning, and use. Topology, on the other hand, refers more to the metrical, geometrical constraints and variables of form that change from one instance to the next. A topological approach to form emphasizes not the shape of an object, but rather its transformational potential and the multiplicity of forces at play in its creation. This requires thinking about forms processually, as events rather than objects, contingent upon the dynamics of their performance. This implies a shift in focus from ”totalizing representations of the material object” to the ”diverse procedures in which forms take shape” (Galloway, 2004).

Bernard Tschumi’s statement that “there is no architecture without program, without action, without event” recognizes the significance of how a space is used–the movement of bodies within it and the duration of their experience – for architecture’s “social relevance and formal invention” (Tschumi, 1994). For Tschumi this offers a means to interrogate a static view of architecture that aligns with ideas of solidity, stillness, coherence and continuity. In contrast he proposes a program of disjunction and dissociations that “trigger dynamic forces that expand into the whole architectural system, exploding its limits while suggesting a new definition.”

Situated Technologies extend this idea of a dynamic space inflected by its inhabitants to include forces that are neither spatially consequent nor temporally concurrent. They are capable of constructing co-present spatial relations that intergate geographically dispersed locales and can draw on a history of transactions stored within memory that have transpired within a given space. This is quite different from the “animate” or “non-standard” morphological experiments popular within contemporary ”digital architecture” research. Such investigations are primarily interested in form-finding techniques with the ”design space” of parametric modeling tools that involves the generation of an array of possible topological variations from which a single instance is selected and subsequently rendered in built form. By contrast, research within Situated Technologies looks to *perform* such morphological variations *over time* in *lived* space by using the components of architecture to organize various networks of relations between material, human and informational actants. Architecture can be sensitized to respond to different actants as diverse as the will of a group of people, the pollen in the air, the stock market index or the fluttering of a butterfly.

One consequence of this approach is that space-making becomes ”participatory.” For example, consider how certain spatial practices involving the use of mobile phones or portable audio devices like the iPod have altered the social space of cities and evidence new ways in which space may be *enacted.* As Bull (2000) has shown, people use portable audio devices in a variety of ways to manage the contingencies of everyday life. On the one hand, the popularity of the iPod points toward a desire to personalize the experience of the contemporary city with one's own private soundtrack. On the bus, in the park at lunch, while shopping in the deli – the city becomes a film for which you compose the soundtrack. These devices also provide varying degrees of privacy within urban space, affording the speaker/listener certain exceptions to conventions for social interaction within the public domain, absolving them from some responsibility for what is happening around them. Talking on a mobile phone while walking down the sidewalk, text-messaging with a friend while on the bus, or listening to an iPod on the subway are everyday practices for organizing space, time and the boundaries around the body in public.

In Japan, the mobile phone (or keitai) has been described by Kenichi Fujimoto as a personal “territory machine” capable of transforming any space – a subway train seat, a grocery store aisle, a street corner – into one's own room and personal paradise (Fujimoto, 2005). Mobile phones there are used less often for voice communications than for asynchronic exchanges of text and images between close circles of friends or associates - exchanges which interject new forms of privacy within otherwise public domains. So while traditional notions of so-called “cyberspace” promised to unlock us from the limitations of offline relationships and geographic constraints, keitai space flows in and out of ordinary, everyday activities, constantly shifting between virtual and actual realms. Mobile phones in this case are less discrete material interfaces to networked information spaces than they are performances, in that they enact new relations between people and spaces. What's interesting is not that urban space itself is changed, more that new hybrid spaces are performed/enacted through habits of mobile phone use.
When buildings and spaces engage these techno-social practices as forces to which they can respond – whether in material ways through mechanically actuating building components or through immaterial ones by manipulating lighting, sound or information flows – the architectural ”system” is expanded to include ”variables” beyond the limits of its current definition. Architecture, in effect, becomes engaged in a ”conversation” with its inhabitants and their actions (Pask, 1969), and its ”design” constantly evolves over a lifetime of use.

**Conclusion**

This paper has attempted to outline a series of transformations in the way we might conceive, design and construct architecture in an age of ubiquitous/pervasive computing. We call this new area of research ”Situated Technologies.” A key aspect of this research looks at a shift from representational to performative strategies. Here, space is less a static image than a ”performance” that is continually evolving through purposeful and random means. Here, Situated Technologies are not simply instrumentalities but also actants in the complex process of space-making, a process that evolves over the lifetime of a building.

As exploratory research, it aims less to propose solutions to known problems than to arrive at precise questions that help us better identify and structure new problems for architecture presented by recent developments in ubiquitous/pervasive computing. New questions and problems include: How might we rethink the design of traditional building components such as windows, doors, walls, floors, roofs, and facades when they are enabled to autonomously access and share information about their states, environmental conditions, or patterns of use and activity? How might thinking about the role of computers and computing in ways aimed not just at simulating the world but also emulating it offer new possibilities to the design process? How might Situated Technologies expand the "architectural system" to incorporate forces and variables beyond the limits of its current definition?

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# S P A C E W A L K I N G
## How to exchange capacities of the moving body and the shaping of architectural space

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# SPACEWALKING
# How to exchange capacities of the moving body and the shaping of architectural space


**Abstract**

The experience of creating and implementing space as such is a major issue. It is in the process of architectural becoming, that the most revolutionary potentials of digital and analogue interactions reveal themselves. My paper confronts a posit made in the conference theme, saying: 'it is still possible to claim that architecture only exist in the analogue world – that architecture as space and materiality in relation to human senses and bodies does not take shape as architecture, until it has been completed'.

Spacewalking exchanges capacities of the kinesthetic body and the shaping of architectural space by use of digital and analogue interactions. The conception of a moving body as generator in the creative process is in focus in actual theories about design practice, concluding that being-a-body in its many scales is fundamentally related to how we generate spatial material. The question is not why but how the body – i.e., which aesthetical and ethical values do we incorporate in the process? How do we literally use the body to construct? Which tools, practices and logic of presentation do we evolve as modes-of-operation?

The paper is based on my research-by-design project named: *mixed movement in the composition plane*. Here I explore the constitution of architectural space letting architectural questions appear through emerging shapes. This work will be produced as an architectural 'game-engine', chosen as a format with potentials of intuitive transference of kinaesthetics and seamless mixes of analogue and digital movements. Spacewalking then is a prototype and teaser to *mixed movement*, completed in Flash format.

In the paper the following issues are discussed, relating to actual design theories:

'Give me a body then':

Passage from the everyday to the ceremonial body, from normal to aberrant movement.

Movement-vision:

Body-movement/sensation-change – kinaesthetics as multi-dimensional experience.

Affectivity and digital image:

Capacity of the sensorimotor body to create the unpredictable.

Body and image - splitting or doubling of perception into machinic and affective vision.

The computer as embodied prosthesis.

Furthermore *Spacewalking* is presented:
*Spacewalking* - series of 'becoming-other':
Constituting architecture.
Series of body-space creation, supplied with:
*Spacewalking* - illustrations:
*Spacewalking* series25.2 - sequences
*Spacewalking* series(25)24.1 - sequences

**'Give me a body then'**

P*assage from the everyday to the ceremonial body,* from normal to aberrant movement. To think is to learn what a non-thinking body is capable of, its capacity, its postures – it is through the body, that cinema forms its alliance with the spirit, with thoughts – says philosopher Gilles Deleuze (GD) in *Cinema 2, the Time-Image.*

'Give me a body then', is first to mount a camera on an everyday body, making the camera invent the movements or positions which correspond to the genesis of bodies, as a formal linkage of their primordial postures. To mount a camera on the body, then takes on a different sense – it is no longer a matter of following and trailing the everyday body, but of making it pass through a ceremony – make it into a grotesque body, but also brings out of it a gracious and glorious body, until the disappearance of the visible body is achieved. The goal of the cinema of the body is not a picturing of the literal body, rather it is to give expression to forces of becoming that are immanent in bodies, as well as the body's receptivity to external forces through which it can transform itself - we barely know what a body can do.

In *Cinema 2 GD* also differentiates between normal and aberrant movement – what we mean by normality is the existence of centres: centres of the revolution of movement itself, of equilibrium of forces, of gravity of moving bodies, and of observation for a viewer able to recognize or perceive the moving body, and to assign movement. Aberrant movement then, is movement that avoids centring in whatever way, and as such being abnormal, aberrant. If normal movement subordinates the time of which it gives us an indirect representation, aberrant movement speaks up for an anteriority of time that it presents to us directly, on the basis of the disproportion of scales, the dissipation of centres and the false continuity of the images themselves. This direct image of time is that of pure virtuality, that affects the visible with a fundamental disturbance, and the world with a suspension, which contradicts all natural perceptions. What it produces in this way is the genesis of an 'unknown body' which we have in the back of our heads.

**Movement-vision**

*Body-movement/sensation-change – kinaesthetics as multi-dimensional experience.* Cultural theorist Brian Massumi (BM) introduces his book, *Movement, Affect, Sensation*, by announcing: 'when I think of my body and ask what it does to earn that name, two things stand out. It moves and it feels. In fact, it does both things at the same time. It moves as it feels and it feels itself moving.' Massumi explores the implications for cultural theory of this simple conceptual displacement: body–(movement/sensation)-change. By connecting body and contemporary media, BM links a cultural logic of variation to question of movement, affect, and sensation, and confronts cultural theory of the past decades. He argues that, in these theories, attention to the literality of movement was deflected significantly by fears of falling into a 'naive realism', into a reductive empiricism that would dissolve the specificity of the cultural domain in a plain, seemingly unproblematic, 'presence' of dumb matter.

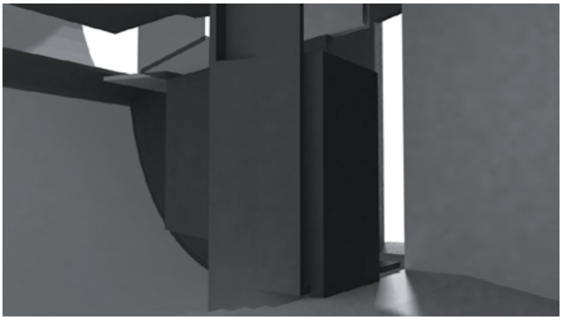
BM reconceives the potential reach of the moving body: 'when we see one object at a distance behind another, what we are seeing is in a very real sense our own body's potential to move between the objects or to touch them in succession. Seeing at a distance is a virtual proximity: a direct, unmediated experience of potential orientings and touches on an abstract surface by combining pastness and futurity. Seeing is by nature synaesthetic, and synaesthesia is by nature kinaesthetic. Every look reactivates a multi-dimensioned, shifting surface of experience from which cognitive functions emerge habitually but which is not reducible to them.'

He introduces the differentiation between movement-vision and proprioception. Movement-vision is an opening onto a space of transformation in which a de-objectified movement fuses with a de-subjectified observer. This larger processuality includes the perspective from which it is seen, and grasps the movement, and only the movement. Movement-vision then names the bodily 'underside' of vision, a form of proprioception orientated towards external perception, whereas proprioception proper designates the body's nonvisual, tactile experience of itself, a form directed towards the bodily production of affection, Brian Massumi says in *Sensing the virtual, Building the insensible.*

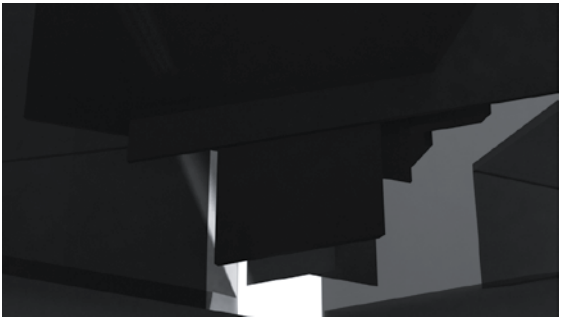
**Affectivity and the digital image**

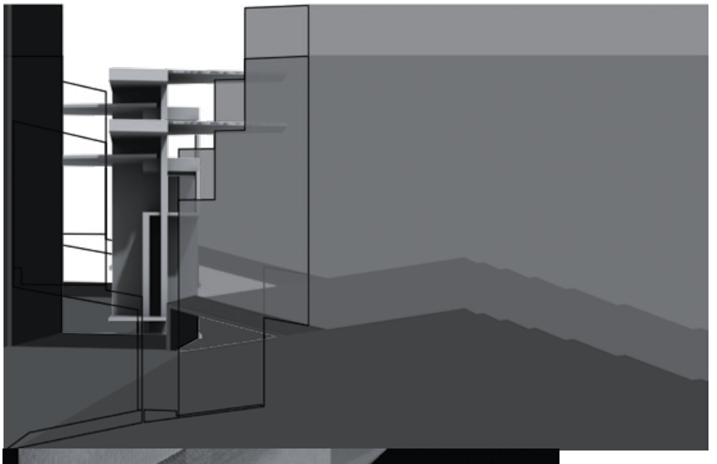
*Capacity of the sensorimotor body to create the unpredictable.* 'There is one image which is distinct from all the others, in that I do not know it only from without by perceptions, but from within by affections: it is my body. I examine the conditions in which these affections are produced: I find they always interpose themselves between the excitations that I receive from without and the movement which I am about to execute, as though they had some undefined influence on the final issue. My body is, then, in the aggregate of the material world, an image which acts like other images, receiving and giving back movement'. A citation of philosopher Henri Bergson in *New Philosophy for New Media*, a major contribution to the question of digital media art, by Mark B. Hansen (MBH).

MBH argues that what he calls affectivity precisely is that mode of bodily experience that mediates between the individual and the pre-individual, the body and its 'virtual' milieu. In this sense, affection supposes a virtual field of forces - it constitutes an internal space which isolates an effort or a force rather than an object or a form. Affectivity is a field of forces that is internal to the body, while perception is a space of external and objective forms. As a spatiality or spacing where the body is felt from within, rather than seen from without, affectivity appears as a sort of permanent and diversified experience of oneself, in a body which becomes in a way the body of someone, and not only that of a living and acting being in general. Insofar as the sensorimotor nexus of the body opens it to its own indeterminacy, it is directly responsible for the body's constitutive excess over itself. In this respect motion functions as the concrete trigger of affection,




PROFILE
MAP





**Series25.2**
Sequence of moving-throught a model, generated from a miroring-left/right figure. Sequence of choosing mask-images. Sequence of mutation.

**Series(25)24**
Sequence of mask-images, chosen from deforming parameters in a model, generated from a folding-inside/outside figure (affected by a mirror figure). Sequence of mutation.

as an active modality of bodily action. Affectivity then is the capacity of the body to experience itself as 'more than itself' and thus to deploy its sensorimotor power to create the unpredictable, the experimental, the new.

*Body and image* - splitting or doubling of perception into machinic and affective vision. Concerning the digital world, it requires us to reconceive the correlation between the user's body and the image. By digitations the 'image' has itself become a process – it can no longer be restricted to the level of surface appearance, but must be extended to encompass the entire process by which information is made perceivable through embodied experience. This process is what MBH proposes to call 'the digital image'.

Today's new media artists offer an alternative investment in the bodily underpinnings of human vision. At the heart of this aesthetic approach to the automation of sight is an understanding of the vision machine as the catalyst for a 'splitting' or 'doubling' of perception into, on the one hand, a machinic form and, on the other hand, a human form tied to embodiment and the singular form of affection correlated with it. Such a splitting of perception is simply a necessary consequence of the vast difference between computer and human embodiment, fundamental for any aesthetic redemption of the automation of sight. New media artists directly engage the bodily dimensions of experience that surface, as it were, in response to the automation of vision. Their work can thus be said to invest the 'other side' of the automation of vision – the affective source of bodily experience that is so crucial to reconfiguring human perception in our contemporary media ecology.

Today, seeing the world is no longer understood as a process of copying but of modeling, a rendering based on data. A person does not see the world out there, she only sees the model created by the brain and projected outwards. This feature of perception and construction points out, how the mechanical simulation of sight has a recursive impact on our understanding and our experience of human vision. This confrontation between two different levels of reality entails a composite experience, an inevitable twinning of contradictory perceptions for a spectator who is simultaneously active in both.

*The computer as embodied prosthesis* let us perceive movement itself in a way that fundamentally alters what it means to see. MBH cites architect Lars Spuybroek saying, that every prosthesis is, in the nature of a vehicle, something that adds movement to the body, that ads a new repertoire of action by changing the skin into an interface, able to change the exterior into the interior of the body itself. The body simply creates a haptic field completely centered upon it-self, in which every outer event becomes related to this bodily network of virtual movement, becoming actualized in form and action. As a vehicle in precisely this sense, new media art configures the body as a haptic field, thereby allowing it to exercise its creative productivity. In short, the body has become the crucial mediator – indeed the 'convertor' – between information and form (image): its supplemental sensorimotor intervention coincides with the process through which the digital image is created.

The computer, Spuybroek maintains, is an instrument for viewing form in time. When we see through the computer, we no longer look at objects, whether static or moving, but at movement as it passes through the object. Today looking has come to mean calculating with the body - we build machines not just to connect perception and process, but to internalize these and connect them with the millions of rhythms and cycles in our body. Insofar as it employs the computer as a prosthetic 'vehicle' to transform the basis and meaning of vision, new media art can be thought of as an apparatus for producing embodied images, resituating the body's sensorimotor capacities by transposing it from the domain of vision to that of affectivity.

**Spacewalking – series of 'becoming-other'**

*Constituting architecture.* As stated in the opening of this paper, space is constructed through geometries, drawing techniques and contextual relations, among others, but not the least also through experiences of creation and implementation as such. Actually, constituting architecture works as a dialogue with the implementation in its many scales, using constructive as well as reflective thinking. Thus, the aim of my project is to challenge exchanges of digital and analogue moves as well as exchanges of praxis and theory, focusing on how they interact and determine/deform each other's logic. A hypothesis of the project is that the conceptual plane can 'get wiser' as well due to interference of the compositional plane of artwork.

Concerning architecture, the above encircled field of body-movement-variable as generator in the creative process can be seen also as an emblem for the still more complex relations that challenge the traditional synthesising form of architectural work, as well as the notion of the product of architecture as a closed aesthetical statement. This challenge accelerates the interest for strategies and tools capable of operating with complex exchanges, like mapping, diagrammatizing, and parametric modelling.

The only aesthetic problem of concern to philosophy, Deleuze argues, is the relation of art to everyday life. Art must not appeal to a transcendent world but to the world here and now in which we live. Everyday life is characterized by repetition as return of the same, and art incorporates these repetitions to expose its limits and to extract what is different and virtual. The task of a work of art is to open a line-of-flight that passes from the actual to the virtual, by interrupting repetition with difference. Art must extract from the habitual repetition of everyday life 'a little time in a pure state'. So the will to art consist of extracting difference from repetition by reversing copies into simulations, opening the capacity of the body to affect and to be affected by change.

The everyday and the ceremonial body, the normal and the aberrant movement, what these poles generate then, are less the difference than the passage from one to the other, the imperceptible passage of attitudes or postures to 'gest' or kinesthetic twists. The act of twisting is a basic mode-of-operation of art. It is related to the image of the body, distinct from all other images, in that I do not only know it from without by perception, but also from within by affection. The material of art is these felt forces of the world – art's problem is to capture forces, not to reproduce or invent forms, i.e., 'not to render the visible, but to render visible'.

*Spacewalking* makes invisible forces and the act of shaping appear and felt, constantly reflecting on the choice of media and drawing techniques as a decisive part of the implementation.

The work exchanges body movements, digital images, and the shaping of space as series of body-space creation.
A series is a sequence of images which tend in the direction of a limit at the same time as they orient and inspire a 'before sequence', and give way to a new series. Spacewalking produces and discusses series by exchanging three qualitatively different levels, each defined both as material and as calculation; both as tied to embodiment and as a machinic form; both composed as well by the use of deformation that relates directly to the body and by the use of transformation that abstracts and thereby make the material dynamic and operational.
The three possible resonating levels have the headings: *Recording* and *Mapping*. *Profiling* and *Diagrammatizing. Modelling* and *Presenting/Twisting.*

*Recording* a normal body movement, you withdraw the forces and rhythm from everyday life as an immediate affect. Creating spacewalking, I actually initiated the process by mounting a camera on an everyday body, mapping a normal forward going movement.
*Mapping* the movement, you transform it into an abstract material, into topological figures open for operation, and hereby create a first passage from the normal to a grotesque or aberrant movement. A normal movement is centred and subordinates the time of which it gives an indirect representation. Aberrant movement presents time directly, on the basis of disproportion of scales, dissipation of centres and a false continuity of images. This pure virtuality affects the visible with a fundamental disturbance, and the world with a suspension, which contradicts natural perceptions potentially producing the genesis of an 'unknown body' which we have in the back of our heads.

*Profiling* an abstract movement-material, you re-insert ordinary body-movements or body-space relations, now defined as simple compositional figures like: folding-inside/outside, mirroring-left/right, stacking-up/down, and displacing-ahead/behind.
*Diagrammatizing* material and figures as syntactical or contextual modes-of-operation, you organize them as powers forming an abstract machine. Power is relation of forces expressed as a diagram, using transformation as its main mode-of-operation. Power does not repress, it produces. It is not formal, but it 'formalizes': composes, limits, stratifies, territorializes and anchors itself in relations of forces, to the extent that it must territorialize or map them in the abstract machine. Power and resistance present two sides of a force as a reciprocal inside and outside – power cannot operate without calling on outside points of resistance: the fluidity and multiplicity of future-oriented forces that never ceases to shake and overturn abstract machines, awakening what is unsought in them. The diagram then, is a drawing-machine operating as a kind of body-scheme or 'abstract vertebrate', using matter not substance, function not form. The forces transformed by the machine can be actualized as widely different structures. Being folded and curled in some sequences of the embryogenesis it might emerge as lion, being twisted and pulled in others it turns out as zebra, the rendered process exposing the thinking with architecture.

*Modelling/deforming/selecting* provisional or emergent shapes, you again use the basic bodily power of articulation: rhythm and deformation. Rhythm articulates the figure, using different intensities like expanding, contracting and attending. Deformation disturbs or twists the figure, relating directly to the different sense organs of the body, passing from one to another.
*Presenting* the rhythmic series of deformations, you re-organize the viewing of the model, searching for potential singularities. What is common for singularities is that they all come from the outside: 'singularities of power caught in relation to forces; singularities of resistance which prepare mutations; and even savage singularities which rest suspended outside, without entering into relation or letting themselves being integrated'. You capture these singularities by interrupting the attending rhythm of the moving-through or moving-of the model, choosing/composing special kinds of views, abstracted intensities, or 'masks' as passages to a different field.
*Twisting* a dynamic model into masks, you work with extraction and re-linking of singularities into new sequences, coordinated/composed as well in time-line as in time-depth. A time-line sequence is the above presented series of masks; a time-depth sequence slows down or stands still in a resonating condition calling for resistance, invited by the open scale of a mask. The mask is a kind of 2.5D image, functioning as a filter including as well as excluding other forces. Because of its ambiguous character, the mask twists the conception of scale, articulation and points of view. You explore the character of a mask-image, looking for special lines and cracks, potentially framing new elements or articulations. This framing then can be used very differently for re-modelling, for example by inserting a new element related by figure but not by scale, rhythm, and point of view. You hereby create a kind of mutation, a double body/rhythm/entering condition, inviting architectural thinking to reconsider potential passages of becoming-other.

In the spacewalking section of the paper I have cited from Gilles Deleuze's Time Machine by DN Rodowick.

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# Networked Embedded Computing: Current Developments for Tomorrow's Architecture

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# Networked Embedded Computing: Current Developments for Tomorrow's Architecture

**Abstract**

*This paper reviews current ideas and technology related to the development of embedded computing systems in buildings. It concludes with a prioritization of systems to be selected for integration in a new research building to be constructed in 2008-09 in Cork Ireland.*

## Introduction

Digital visualization has transformed the process and products of architectural representation. The ability to digitally model complex geometric surfaces, and to directly link digital models with component manufacturing tools, have also demonstrated their potentially dramatic impact on the appearance of certain built works of contemporary architecture. Less obvious at present is the impact of embedding computing into the actual fabric of architecture. This is not surprising, as these components operate at the meso-scale, measured in millimeters and centimeters. Embedded systems may however become the primary area in which convergence of the digital and physical worlds significantly impact daily human experience.

## Historical context

The current work is being carried out as part of a multi-disciplinary team of fifteen partners from five different institutions under the acronym *NEMBES*. The team has received funding of over 13 million Euros to undertake research, to support teaching and technology transfer, and to build a new facility to serve as a centre for such work, as part of the Irish government's PRTLI4 scheme. The author is providing an architectural input to the investigation of the potential, and the effectiveness of networked embedded systems, and is contributing to the development of their application in the built environment. This is a progression from earlier work in the design of 'smart' homes (Chapman & McCartney, 2002) and the study of occupant reactions in "intelligent" office buildings (McCartney and El-Bastawisy, 1997). This paper is a first stage in addressing the requirements of the 2,000 square metre new building for the NEMBES team. Following an initial review specific embedded systems which meet the requirements of utility, economy, and robustness, in the context of the new building, will be identified.

Two or three decades ago, discussion of *intelligent buildings* would have been dominated by the development of automation made possible by centralised Building Management Systems providing control of HVAC and security functions. The personal computer at that time would still have been a hobby interest for many, rather than a vital work tool. A decade ago, attendants at an international conference on *Intelligent Buildings*, accepted the proposition that the primary application areas for smart systems were to provide enhanced control in three areas: HVAC and energy, security, and entertainment. By this time, computers were ubiquitous. Ubiquity is now being replaced by pervasive computing. We are increasingly surrounded by microprocessors applying arithmetic logic to tasks which we are not even aware require the application of calculation. Not only do we carry lap-top computers in our shoulder bags, but we carry or wear microprocessors in our watch, PDA, mobile phone, and our children's toys. As Addington and Schodek (2005, p202) point out: *"Already the human body is 'tethered' to the digital world through the many wearable and portables devices each of us routinely carry"*. In such an environment, we would hesitate to call computer controlled heating, ventilating and air conditioning evidence of an intelligent environment. Addington and Schodek, (2005, p203) distinguish "intelligent" from "smart". At one point they associate smart sytems with the "fetishisation of gadgets" and argue that: *"The aspirations of intelligent environments, however, are higher, as they must operate in multiple contexts and simultaneously interact with the transients behaviours and desires of humans"* They envisage a future in which *"systems become smaller and more discrete, freeing our bodies and perhaps our environments from an overarching web of control."* (Addington and Schodek, 2005, p20). This surely is a goal more worthy of architecture, than the mere display of the latest products of technology. However achieving this goal will require some appreciation and understanding of the smart systems and materials which will be constituents of the intelligent environment.

**Technology**

Smart systems depend on sensors which respond to specific environmental conditions. For useful effects, these are linked to actuators which create signals to produce electro/mechanical changes. Photo-sensors for example, detect reductions in daylight, and send signals to devices which increase the level of electrical illumination. Smart materials incorporate the sensor and actuator functions in one element, which also serves some other function. Thermo-chromic glazing for example, automatically reduces its transmission properties when its temperature exceeds a specified level.

Ritter (2007) divides smart materials into three categories according to the nature of changes over which they provide control: property-changing, energy-exchanging and matter-exchanging. Under these categories he identifies the following functions:

Property-changing
- Shape
- Colour and optics
- Adhesion

Energy-exchanging
- Light emitting
- Electricity generating
- Heat storing

Matter-exchanging
- Water storing
- Gas storing

Ritter's (2007) book is particularly useful in providing images of the impact many of these materials could have on our built environment. Although many of the changes in the materials he discusses take place at the molecular scale, these changes can affect the patterns and colours of large areas of materials. He demonstrates the visual effect of dichroitic filters coating glass surfaces used in chandeliers in the Copenhagen Opera House. More dramatically, he illustrates the vivid colours in the facades of the German Research Foundation in Bonn, created from the work of artist Michael Bleyenburg with holographic optical elements.

The potential contribution of smart systems and materials, presented in such recent works as those of Ritter (2007), Addington and Schodek (2005) and Campagno (2005) have been mapped against the fundamental Vitruvian qualities.

| VITRUVIAN QUALITIES | "SMART" SERVICE |
|---|---|
| Firmness | Stress detection |
| | wear/tear degradation |
| | emergency responses |
| Commodity | Security |
| | Communications |
| | Communications |
| | HVAC thermal control |
| | Adaptability |
| Delight | AV edu/entertainment |
| | kinetic beauty |
| | serendipity |

TABLE 1
**The potential services offered by "smart" systems mapped against the fundamental Vitruvian qualities of architecture.**

Networked embedded technology enables ordinary materials, and component assemblies to behave in a similar way to inherently "smart" materials, by introducing sensors, logic processors, power systems and communications into those components. The NEMBES research team has identified a number of areas which will be the subject of particular attention in the R&D programme for the next three years: miniaturisation, wireless communication, massive connectivity and self-learning algorithms.

*Miniaturisation* will enable the increasing use of networked microprocessors in smaller building components, reduce the visual impact of such devices, and enable their use in identifying users and equipment (particularly utilising RFID technology) for purposes such as tracking, and inventory control. Sensors implanted in materials will be able to measures stress in structural elements, deterioration in properties such as thermal resistivity, and provide information for maintenance and replacement. Miniaturisation will also be a major contribution towards the increasing portability and wear-ability of sensors, signalers and communication devices.

*Wireless communication* is of particular interest to the team, together with the software, or middleware, required to manage connected arrays of embedded devices. Such networking is a distinctive feature of the intelligent environments promised by the current technological developments. Wireless communication in buildings will increase the flexibility of architectural spaces in terms of their future use. Rather than providing hard-wired solutions to all potential data distribution requirements, wireless technologies will enable adaptation to future needs. This can be seen in contemporary applications featuring wireless switching in large commercial spaces. This enables future sub-division of workplaces without the need for expensive re-wiring. Standards such as WiFi provide for wide bandwidth communication including demanding applications such as video transmission. *Bluetooth* provides for narrower bandwidth for simpler data transfer across shorter distances. The *Zigbee* standard, which lies between the two in its capabilities has attracted much attention in recent years and has found application in many building lighting control systems.

M*assive connectivity* will play an important role in work to be carried out with the Cork City Highways department where road safety and traffic management will be linked to a large number of sensors embedded in the road, signals and crossing indicators. Such developments may have future applications in coordinating the behaviour of multiple linked components in buildings.

*Self-learning algorithms* are used in complex systems where the optimum response to given environmental conditions is difficult to predict in advance. They monitor their own behaviour, the resultant environmental effects, and attempt to gradually improve their responses through iterative processes.

The potential “smart” services, shown in Table 1, were mapped against the areas identified as priorities for research and development. It can be seen in Table 2, that wireless communication has a potential effect on all the “smart” services identified earlier. Miniaturisation is also a significant feature in the development of over 60% of the “smart” services. Massive connectivity is not considered to have a role to play in current buildings, but self-learning algorithms have been identified as having particular value in improving the control of the thermal and luminous environment, and hence in reducing the carbon footprint of buildings. The immediate urgency associated with such functions is likely to lead to rapid development in this area.

All the identified R&D areas are seen as having potential significant impacts on the potential for increasing delight in future buildings. These impacts range from the role they play on increasing access to information and entertainment via the audio-visual channels which can be made available throughout future buildings. More intrinsic to the building, is the potential for the beauty of a building to be seen increasingly as related to its kinetic performance, as more use is made of mobile components such as retractable blackout screens, light shelves, shading shutters, insulating panels and ventilators are deployed. Furthermore there will be an increasingly complex and un-predictable interweaving of the effects these components have on each other. A reduction in daylight may increase the electric lighting, which may call on an increase in cooling ventilation and reduction in the solar transmittance of the windows. This may lead to damaging clashes where one system prevents the intended operation of another. However, whilst the building services industry might think of such interaction as a prime case for clash detection, the telecommunications industry would describe it as *feature interaction*. So long as the dangers identified by clash detection can be removed, the serendipity of feature interaction may become a source of pleasure to building users as the emergent behaviours of complex systems may take on some of the beauty of natural systems such as wind ripples on the surface of water, and cloud formations.

| R&D TOPICS | FIRMNESS | | | COMMODITY | | | | | DELIGHT | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Stress Detection | Wear & Tear | Emergency Responses | Security | Comms. | HVAC Light | Tracking | Spatial Adapt. | A.V | Kinetic Beauty | Serendipity |
| Miniatur-isation | O | O | | O | O | | O | | O | O | O |
| Wireless Comms. | O | O | O | O | O | O | O | O | O | O | O |
| Massive Connect-ivity | O | O | O | | | | | | | O | O |
| Self-learning algorithm | | | | | | O | | O | O | O | |

TABLE 2

**Circles plot those areas of potential "smart" services in a building which might be affected by the NEMBES research programme.**

## Conclusions

From the analysis in Table 2, it would be desirable if the new building for NEMBES was to demonstrate innovative use of wireless communication and miniaturisation, and/or design facilities to support design teams in using these technologies.

Five member organizations in the NEMBES team have existing achievements and interests that might inform the "smart" systems to be embedded in the new research facility. The Cork Institute of Technology Centre for Adaptive Wireless Systems have developed a system for tracking the location of individuals within their labs, and software for visualisation of the field covered by wireless transmitters/receivers in an office, to assist in the efficient positioning of such devices. University College Cork Department of Civil and Environmental Engineering are investigating how embedded technology can enable management, inspection and maintenance teams to interact seamlessly with buildings. The Knowledge and Data Engineering Group at Trinity College are involved in the communication across massively connected networked embedded systems. They have also developed a programme to provide a walk-through visualisation linked to a two-dimensional system view that takes into account lags in sensor reporting, blind spots caused by the building geometry and the location of sensors. The Tyndall Institute are producing prototype devices capable of sensing, processing and communicating, with built-in power generation, all in a device which fits within a 1 centimetre cube. The Cork Centre for Architectural Education have an interest in creating a shared, multi-disciplinary design visualisation space in which various types of design simulation can be carried out.

Linking these developments and interests, it is intended to create a building with moveable partitions which enable various configurations of laboratories and offices. Potential configurations will be simulated in a digital model of the building. Actual movements of occupants in the building will be recorded, and these will be used as the basis for creating various walk-through tests of the potential building layout variations. Their movements will be logged as real-word input to the digital simulation of the building as constructed, and it is hoped to produce a variety of narrative-based scenarios suitable for testing of future reconfigured labs and offices. It may be possible to use this method to develop a methodology for creating generic walk-through digital model tests for specific building types, initiallythose in which movements and timetables are particularly constrained; for example schools, museums, and art galleries.

A testing/demonstration laboratory will be created in the glazed south end of the proposed new NEMBES building. It is proposed to provide opportunities for creating an augmented reality simulation of designed environments enhanced by embedded technologies. The intention is to enable design teams to enter a shared space, with some of the functionality of a CAVE (Computer Assisted Virtual Environment), coupled with a partially physical test space in which real objects will be combined with 3-D projections of walls, windows, furniture etc. The glazed wall in this space will require layers of material providing different types of performance which will include: blackout, solar transmission control, and information display. It would also be desirable if the external appearance of this window wall were able to communicate something of the functionality and delight of a “smart” system, exploiting the kinetic features, and serendipity possible with such systems.

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# Digitizing freeways: researching urban resources

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# Digitizing freeways: researching urban resources

At the beginning of his study on Los Angeles *Los Angeles: The Architecture of Four Ecologies* Reyner Banham writes " ... like earlier generations of English intellectuals who taught themselves Italian in order to read Dante in the original, I learned to drive in order to read Los Angeles in the original (Banham 1971:23)." Banham implies, that Los Angeles can only be experienced while driving. The metropolis, the 'urban sprawl', cannot be experienced walking but only through the car. 'Autopia' became one of the 'Four Ecologies' of Los Angeles and he states that the 'automotive experience' "prints itself deeply on the conscious mind and unthinking reflexes (ibid.:214)." Cees Nooteboom draws upon this image of the city in his essay " 'Autopia'(1973) and Passages from 'The Language of Images'(1987)" and writes about the character of Los Angeles: "It is, if one can say this, a 'moving' city, not only a city that moves itself – breaks itself down, builds itself up again, displaces and regroups itself – but also a city in which movement, freedom of movement, is a strong premise of life (Nooteboom 2001:15)." Nooteboom continues how the everyday live depends upon the system of the road. The constant Movement of the city repeats itself: "The other cars are mirror images of you in your car. You are driving behind yourself and in front of yourself, next to yourself and opposite yourself, you are the taillights of the one in front of you. Everything is on the move (ibid.:21)."

The above description can be seen as a typical everyday experience expressing mobility and connectivity typical of our times. The highway stands for constant movement in the 'real' reality and also constitutes an image for the digital exchange of information in a 'virtual' reality. Further the highway is a cultural space, a phenomenon depicted in the fictional world of films.

In the context of the Shinkenchiku Housing competition 2007 we were investigating possible urban resources that provided for habitation as well as addressing contemporary issues of urban sprawl. Based on our interest in the cinematic experience of contemporary urban space we started to look at Los Angeles and freeway systems where smoothness and the mobile view are the main features. At the same time the discussions about mega-cities in particular on Lagos, Nigeria offered a different perspective on freeway systems, where the idea of constant movement turns into the opposite. Both systems adapted to the local situation and offer a valid public space. (FIG 1)

### Heat : the drama of movement

Inverting the relationship between American urban space and the cinema screen, Jean Baudrillard argues that the cinema – its spectatorial possibilities, its simulated visualities – are not restricted to the screen but extended outward into our urban reflexes. "The American city seems to have stepped right out of the movies", he writes: "To grasp its secret, you should not then

**Figure 1**

begin with the city and move inwards towards the screen; you should begin with the screen and move outwards toward the city (Baudrillard 1988:56).”

One of the films that depict the Los Angeles Highway experience is Michael Mann’s *Heat* featuring Al Pacino and Robert de Niro. In the scene in which Vincent Hannah (Al Pacino), head of the Los Angeles Police Department arrives at the crime scene under one of the main freeway junctions, he immediately grasps the complexity of the planned crime in relation to the geographical specificity of the site. Vincent states how the chosen spot incorporates perfect timing, directionality, surveillance and disappearance. In *Heat* this is a strategic way how Michael Mann introduces a typical situation where the static is positioned within the fluid. In another related and crucial scene, which is also a turning point in the film, movement becomes the driving force. This time Vincent enters the scene, which takes place on the freeway, from above via helicopter. The scene dramatizes a smooth inter locking of different motions and builds up towards the unexpected encounter between the two main characters. Vincent meets his opponent, the head of a crime business, Neil Macauly played by Robert de Niro. The movement of two cars on the highway is choreographed by the camera view. The camera guides the spectators view through intertwining views of the city, framed by the windshield. In this scene the inside of car and outside highway merge into one spatial experience. Hannah is not only relying on his own view, but is guided by the above helicopter through walkie-talkie, which ads a further view onto the freeway system.

This relates to one of Giuliana Bruno’s claims that the parallels between cities and architecture entail a total overhaul of how we once conceived film viewing. No longer “fixed” as a voyeur, the spectator is now a “voyageur” who moves through a film as someone walking through a building or a city, assembling views according to whom and where she is and what she wants to see (Bruno 1997:10). In the described scene of Vincent and Neil the movement of the voyageurs is channeled towards a speeded up car chase.

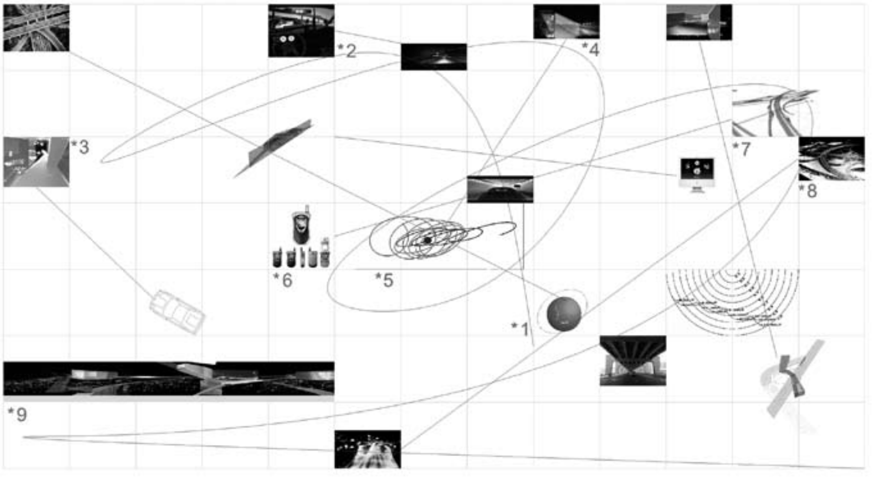



**Figure 2**

While in *Heat*, the space of the freeway is constructed as a space of exchange, building up tensions between the two characters, it shows a potential of how public space can be configured using the highway as real space. Views and movements that are generated on the highway can constitute elements for different public spaces.

Anne Friedberg goes even further and describes the experience of the public space as experienced from the private space of a moving car. She starts from the idea of driving as a mobilized form of flanerie: "Driving is a motorized form of flanerie, and the driver replays the urban fluidity of the pedestrian whose itinerary was determined by boulevards, alleys, passageways. The drive can avail itself of the potentials of psychogeographical drift, the situationist derive (Friedberg 2001:184)." She describes the specific perspective from the inside of the car: "Driving transforms the mobilized pedestrian gaze with new kinetics of motored speed and with the privatization of the automobile 'capsule' sealed off from the public and the street. But the visuality of the driving is the visuality of the windshield, operating as a framing device (ibid.)." This leads to an urban situation where much of the vernacular architecture is built for the driver's view. Buildings become scenic attractions designed to lure motorists from their cars. Seen through the windshield the architecture obeys the spectatorial logic determined by the topography of the freeway and its off-ramps (s. ibid.). A topography which was used by Neils (de Niro) crime gang as a strategic point for escape.

We can see from these early arguments a two-way relationship between cities and cinema. In the first place, not only does the cinematic image come out of the urban experience; it also incorporates such an experience in a new aesthetic principle, an aesthetic of movement where instability becomes paradoxically the principle structure. We are interested in relating these temporal and fleeting images that are typical for the highway and cinematic experience to an architectural form and the urban landscape. (FIG 2)

### *Flow* : emerging counter sites

The idea of the *Flow* project picks up on the phenomenon of a mobile view but the captivity of experiencing the urban space from the car is questioned. Baudrillard describes driving as private telematics in his essay “The Ecstasy of Communication”: “where [a] person sees himself at the controls of a hypothetical machine, isolated in position of perfect and remote sovereignty, at an infinite distance from his universe of origin. Which is to say, in the exact position of an astronaut in his capsule, in a state of weightlessness that necessitates a perpetual or orbital flight and a speed sufficient to keep him from crashing back to his planet of origin (Baudrillard 1998:128).”
Should the automotive experience be opened up in order to initiate an architectural project? Are there options for developing new urban strategies in order to populate the edge situation of the freeway to enable communication and physical transition? How can the scenography of the city be incorporated into the highway system and vice versa?
Our proposition is: merging the highway and the city in order to make space at the edges of the highway for new forms of habitation which straddle the edge between static and fluid lifestyle and new forms of social arrangement.

### Counterspaces

The processes of transformation in a time of technological and social change allows for a new evaluation of transportation and habitation systems which might lead to new social and public spaces. The biggest potential for urban development within mega-cities was seen at the edge of the highway, which formulates a borderline within the city. For this edge situation we started to develop occupational strategies, looking for adequate programs in relation to digital design methods. (FIG 3)
These new sites that straddle the edge of the highway can be related to what Michel Foucault has described as ‘heterotopias’ – “places [that] are absolutely different from all the sites that they reflect and speak about (Foucault 1986:24).” In their irreducible heterogeneity in relation to the surrounding spaces, they are “something like counter sites, a kind of effectively enacted utopia in which the real sites, all the other real sites that be found within the culture, are simultaneously represented contested, and inverted (ibid.).” Among those sites Foucault lists the transportation system such as trains or sites of temporary relaxation such as cafes and beaches. He discusses these sites as examples of a particular principle of heterotopia: The capability “of juxtaposing in a single real place several spaces, several sites that are in themselves incompatible (ibid.:25).” The idea of the counter-site, seems also applicable to the freeway system. One could imagine that these spaces allow for the emergence of different social spaces that are not linked to a known type of program. As another thought one can relate this idea of counter sites and new programs, to processes happening right now in mega-cities like Lagos, Nigeria where infrastructure (a highway system) has been imposed as an image of modernity. In the seventies the entire city was covered in a network of highways and motorways. Twenty years later the image of smoothness and continuity has become dysfunctional to the traffic flow. Through permanent traffic congestion the idea of flow turned into a strategy of go-slow processes. The highway became an informal exchange area where every gap between vehicles became a

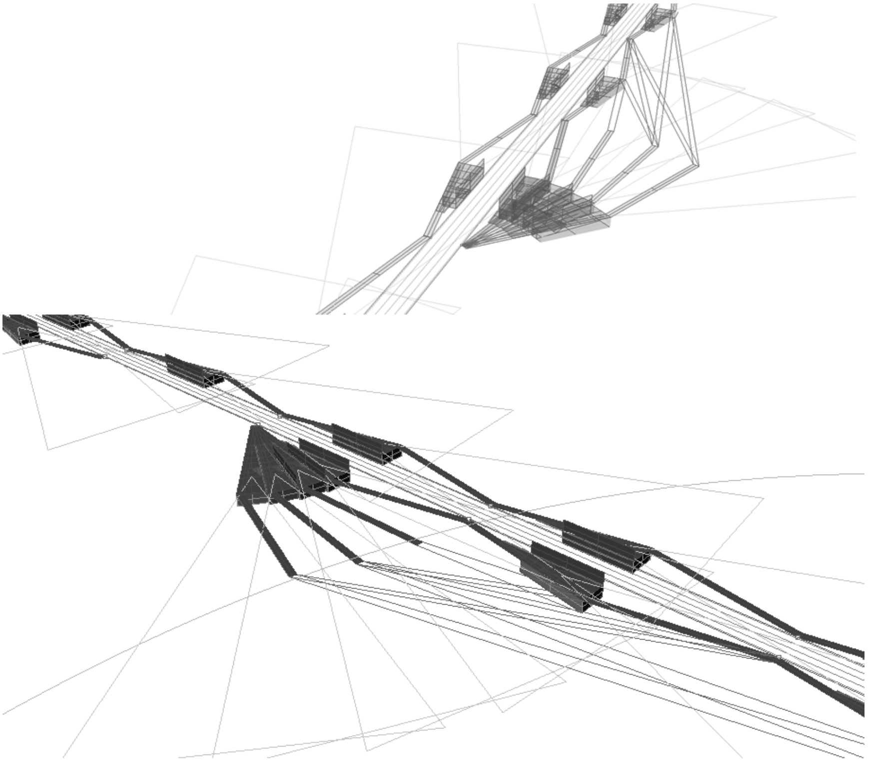


**Figure 3**

continuous interface between vendors and consumers in cars, a high-density public place. The idea of infinite flow has turned into the reverse. Rem Koolhaas describes this phenomenon in "Fragments of a lecture on Lagos": "What seemed an improvisation proved to be a systematic layering where the enormous amount of miniscule transactions necessary to stay alive in Lagos […] where made possible through the arrangement, intersection, and mutual confrontation of people and infrastructure (Koolhaas 2002:179)." These characteristics made us think that mobile forms of organization could be transferred to the urban sprawl. Highways in mega-cities could act ideally as zones where the technological and the social merge to create new forms of interaction. With this possible political potential of the imagined counterspaces on the highway one can refer to Saskia Sassens argument, that globalization and digitalization signal new possibilities for political action. She argues that power has not dispersed geographically nor gone entirely virtual. The digital, as she points out, is never only technological. Even the realm of finance, which is perhaps the most highly digitized activity in our time, cannot be thought of as exclusively digital. Electronic financial markets require enormous amounts of material, not to mention people. Moreover, what takes place in finance is deeply inflected by culture, material practices, and imaginaries that exist alongside cyberspace. According to Sassen, the promise of the city in an era of globalization is precisely what the city promised in times past: "The other side of the global city," she writes, "is that it is a sort of new frontier zone where an enormous mix of people converge. Those who lack power-those who are disadvantaged, who are outsiders, who are members of minorities that have been subject to discrimination - can gain presence in global cities, presence vis-à-vis power and presence vis-à-vis each other (ibid.:25)."

**Subeconomies and programming counterspaces**

The idea of breaking the smooth flow of the highway creates the necessary voids for sub-economies to emerge. Out of the external and economical limitations one often can observe new loose self-organizing formations that are essential for the renewal of the city from the inside. Through new media that are more and more available social groups can gain easier access to these processes and possibilities. As a consequence specific areas like highway edges might acquire a different meaning, as a cultural political turning point. These places of discontinuity within the city, which started as a fracture, have gained a space through processes of layering and accumulation. Sassen has described these places – developed from in between situations – as new terrains. "In constituting them as analytic borderlands, discontinuities are given a terrain rather reduced to a dividing line (ibid.:17)." This phenomenon allows for long-term transformative processes of the urban highway context.

Methodologically, the construction of the counter spaces on the edge of the highway pivots on the installation of a mix of economic and habitational operations, which is constituted by a series of different types of small hyperactive industries. Trying to describe some of the operations leading to a new highway ecology one might have to highlight certain advantages like the possibility of instant communication, virtual as much as the direct physical contact plus the quick speed of moving on the highway with its instant mobility. One can imagine that these counter spaces can develop or adapt depending on demand and larger cultural processes.

**Designing counterspaces**

Examining the pattern of the highway system we located points of interventions. Existing generic moments within the highway system, for example the layering of a motorway exit, fly-over and cloverleaf situations were interpreted as specific geometries in their relation to program.

These located geometries became blueprints for a specific spatial experience within the new habitable structure. This approach offered the possibility to relate the movement of the real highway space with a typology of forms, generated by motion. These principles were used for designing individual units: the *plane type*: a one directional path on zero level, a smooth continuous movement; *slope type*: a one directional path splitting into two paths where one stays on zero level the second moves up and down; the *warp type*: two paths leading in two directions are creating an intersection through weaving; the l*oft type*: one spiraling path that incorporates different directions at different heights. (FIG 4)

The aim is to create a spatial experience which comes close to the experience of an unfolded space where the inside and the outside turn into one immersive experience. Our interest relies on the spatial experience that includes views and speed and suspense. Thus the physical ex-

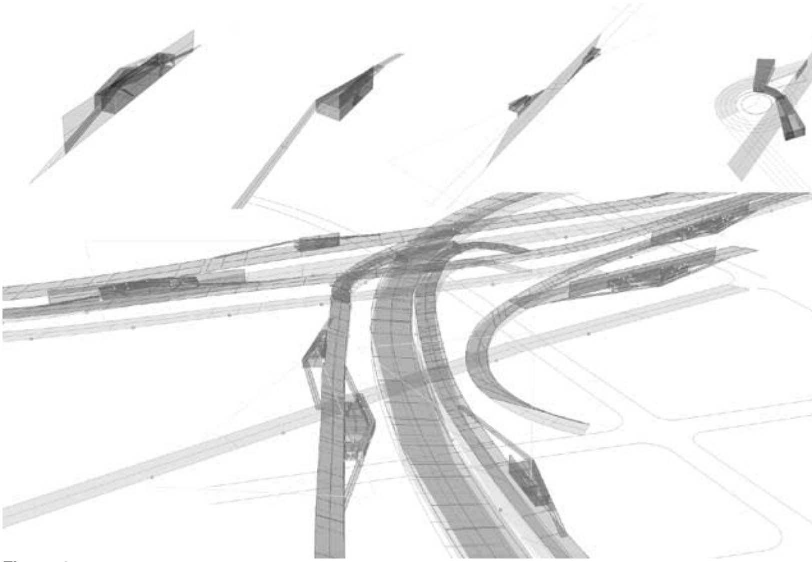


**Figure 4**

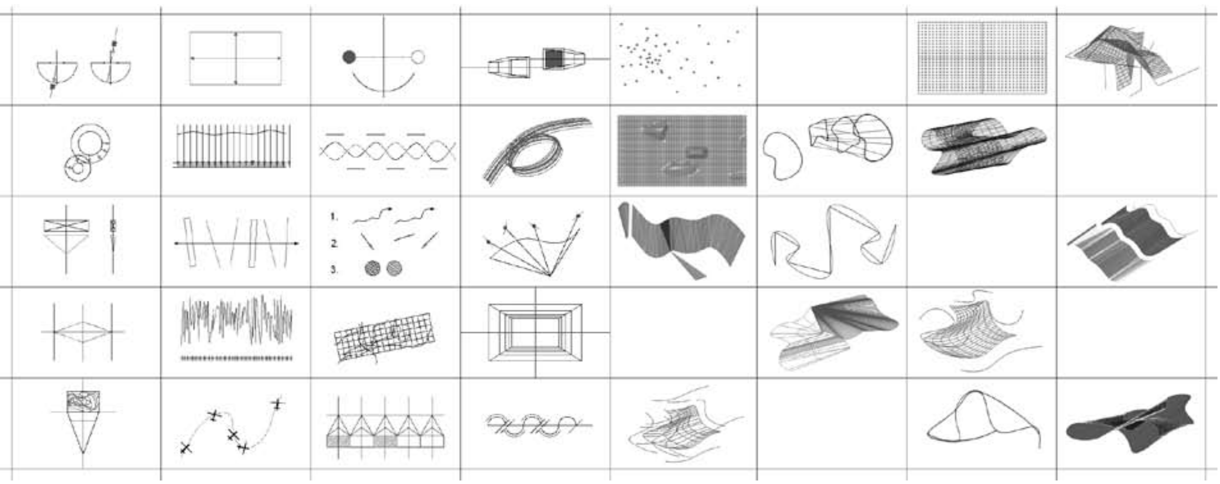
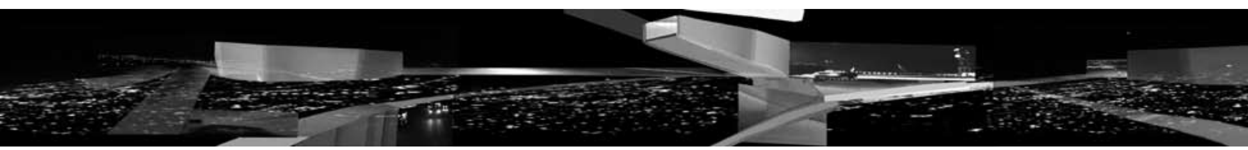


FIG 5

FIG 6



perience points towards the psychological realm. Trying to express these spatial conditions in an architectural proposition we examined the potential of digital tools in relation to dynamic forms. Within that process digital tools were confronted with analog cinematic tools like: long shot, traveling shot, swish pan etc.. Thus the cinematic tools function as an interface between the experience of the site and the form experiments. (FIG 5)

**Counterspacing freeways**

In the future one can imagine, that these units connect to larger communities along the highways, forming temporary adaptable industries and housing structures. Within this context CAD/CAM technologies could play a significant role enabling mass production in relation to a specific site while still achieving low cost structures within expensive high-cost mega cities. The scenario could be imagined as self-organizing and adaptable over a certain period of time allowing for flexibility in order to incorporate different social groups, so they can appear and disappear over time. These ways of accumulations articulate an alternative to commercial urban occupation.

Concluding one could say that the approach pursued shows a possibility how to develop a spatial concept in relation to movement and time combining cinematic and digital tools. (FIG 6)

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**Credits**

FIG 1. Los Angeles and Lagos, Nigeria, web images

FIG 2. Interconnectivity © bredella /lahusen

FIG 3. Occupational strategies © bredella /lahusen

FIG 4. Flow types and perspective © bredella /lahusen

FIG 5. Digital and film tools © bredella /lahusen

FIG 6. Perspective flow space © bredella /lahusen

# #B1

Wanda Dye

# Towards Difference in the Everyday Landscape

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Wanda Dye

# Towards Difference in the Everyday Landscape

### Introduction

A significant amount of our everyday landscape is comprised of repetitive, generic, prototypical design. Developer and corporate driven "one size fits all" quick-fix prototypes and spaces are the status quo in our persistently complex, continuously evolving, globalized world. Alternative approaches to current paradigms of sameness are imperative. Our daily experiences, from our homes, to work, to shopping, to driving, are comprised of interfaces with ubiquitous non-specific design, especially in the United States. Where do critical agendas, research, and design play a part in this moving target world? Margaret Crawford in *Everyday Urbanism* states that "the everyday city has rarely been the focus of attention for architects or urban designers, despite the fact that an amazing number of social, spatial, and aesthetic meanings can be found in the repeated activities and conditions that constitute our daily, weekly, and yearly routines."[1] This dilemma is further articulated In Ellen Dunham-Jones's article "Seventy-five Percent", where she states that:

*Architects design only a small percentage of what gets built in the United States. Still, it is astonishing that in the past-century a vast landscape has been produced without the kind of buildings that architects consider 'architecture,' a landscape almost entirely uninformed by the critical agendas or ideas of the discipline. This landscape is the suburban fringe, the outer suburbs and exurbs – the landscape often called 'urban sprawl.' The favored venue for development associated with the post-industrial economy, this landscape accounts for approximately 75% of all new construction – yet it is shunned by most architectural designers.*[2]

One of the many challenges for these homogenous landscapes is how to design repetitive prototypes and spaces that can adapt and/or even encourage difference. For they are not going away, so how can we begin to critically engage them? French philosopher Henri Lefebvre observed the complex contradictions of capitalist space that is "oriented toward the reproducible". In his text "Space: Social Product and Use Value", he states:

*Oriented toward the reproduction of the social relations of production, the production of space enacts a logic of homogeneity and a strategy of the repetitive. But this bureaucratic space conflicts with its own results. When space is of this nature, occupied, controlled, and oriented toward the reproducible, it soon sees itself surrounded by the non-reproducible: nature, the site, the locality, the regional, the national, even the world level.* [3]

He continues this critique of capitalist space in that it negates all differences.

This formal and quantified abstract space negates all differences, those that come from nature and history as well as those that come from the body, ages, sexes, and ethnicities. The significance of such factors dissimulates and explodes the very functioning of capitalism. The dominant space, that of the centers of richness and power, is forced to fashion the dominated spaces, that of the periphery.[4] (Or in this particular situation, the everyday landscape comprised the suburbs and exurbs, as stated earlier by Dunham-Jones).

Typical prototypical architecture such as franchises, public space, and spec housing are based on the repetitive and yet are deployed in many different situations. These differences may manifest itself in several ways, whether it is a difference in climate, site, culture, budget, lifestyle, program, or even aesthetics. New principals such as mass customization have tremendous potential in creating alternatives to the production of sameness, (what is unfortunately a common outcome in most prototypical architecture). Mass customization pioneer Robert T. McTeer states that, "Things used to be made to order and made to fit. But they were labor-intensive and expensive. Mass Production came along and made things more affordable, but at a cost – the cost of sameness, the cost of one-size-fits-all. Technology is beginning to let us have it both ways. Increasingly, we're getting more personalization at mass-production prices. We're moving toward mass customization."[5] Even though McTeer is speaking mostly about product design, more and more architectural practices are tapping into these new principles and technologies so that something that is repetitive doesn't necessarily have to be generic, or the same everywhere. It may negotiate and/or even initiate difference.

For example, in the research and design studio presented here, the notion of difference was addressed in several ways. Through assigning the students to choose five sites and cities with extreme differences, their repetitive systems were forced to adapt to local constraints. These differences maybe related to climate, culture, site boundaries, and so on. Since most capitalist driven architecture and spaces are, as stated by Lefebvre, based on "the logic of homogeneity and a strategy of the repetitive", the students were asked to design prototypes and spaces that are easily reproducible and yet respond to the surrounding *"non-reproducible*: (such as) nature, the site, the locality, the regional, the national, even the world level."[6] We were curious as to how the local conditions affect the overall global system and vice versa; thus acting as a counterpoint to the universal "one size fits all". For this is could be one of the many future challenges for global practices designing repetitive prototypical architecture and spaces.

**Teaching Toward Difference: Rethinking the Global Franchise in the Everyday Landscape**

Teaching toward difference in everyday landscape has been a topic of interest for several years. Past research and design studios and seminars I have taught had real "clients/collaborators", two of which were outside corporations tapping the studios for rethinking their prototypes. They range from franchise restaurants, to travel plazas, to affordable housing, to public spaces. These types of projects or programs may not be glamorous, or heroic in the conventional sense, but, as stated earlier by Dunham-Jones, comprise over 75% of our everyday built landscape. Therefore, I believe these types of projects should not simply be overlooked, as stated by Crawford, or negate difference as stated by Lefebvre, but taken head on, with critical optimism and opportunism.

The research and design also intends to learn from complex realities and propose an agenda for critical operation within these landscapes. It strives to look closer at the hard pragmatics of what tools, technologies, and most importantly, philosophies our pedagogies and practices could tap into in order to create *difference* out of a globalized world riddled with *sameness.* Furthermore, learning from the problems existing within the everyday landscape allows for their transformation into design opportunities and potential interventions.

The most recent work presented here was developed in collaboration with the global franchise restaurant company Brinker International of Dallas, Texas and fourth year undergraduate architecture students at the University of Texas Arlington. The work seeks alternatives to the generic, in particular, global franchise prototypes and "public" spaces. The approaches strive to adapt and respond to *difference* and outside forces such as site, climate, budget, culture, and aesthetics. It also attempts to examine the infrastructural implications of a city or space by attempting to create place within the public realm – another alternative to the status quo approaches of disconnected "objects in the field". Our collaborator, Brinker International's in-house architects, are in the process of designing a new concept restaurant called *Chili's NOW,* an offshoot of their Chili's To Go component presently located within their main restaurants. The students in the studio were charged with rethinking prototypes for *Chili's NOW* – a new drive up/take out global franchise. Chili's presently has approximately 1500 restaurants and new ones under construction in various cities around the world - from Mexico City to Atlanta, from Seoul to Plano, from Los Angeles to Belfast.

The studio provided an exciting opportunity for the faculty, students, and Brinker International to research and rethink one of the most ubiquitous typologies in our global everyday landscape: the franchise. Comprised of interchangeable and collaborative design teams, the students presented their research and designs to Brinker's in-house architects throughout the semester. In terms of rethinking the prototype, the students were charged with designing systems to accommodate different sites and situations. Unlike the universal "one size fits all" franchises currently deployed, the studio, through being charged with designing for difference was able to rethink existing "status quo" models based on sameness. Various local and global differences and constraints such as site, program, budget, branding, time, climate, culture, circulation, and efficiency were constantly negotiated and seized as design opportunities rather than design limits. In addition, they were to consider, through alternative site strategies, how the prototypes could contribute to the city's urban/suburban infrastructure and public realm. Principals of mass customization, 'file to factory' approaches, utilization of prefabricated and/or modular systems, as well as sustainable material and construction techniques, drove the design process and afforded innovative responses to the multiple design constraints. Various media from hand sketches and sketch models to CAD CAM drawings and models were utilized to study various modular, customizable components and assemblies. In addition, selected texts such as *Pre Fab Prototypes: Site Specific Design for Off Site Construction*[7] by Mark and Peter Andersen and *Re-Fabricating Architecture*[8] by Stephen Kieran and James Timberlake, "Prefabrication and Sustainability" by Kevin Pratt, "Seventy-five Percent" by Ellen Dunham-Jones, as well as my own research articles[9] formed the nucleus of our weekly roundtable discussions.

**Situating the Re-Thinking: Systems and Processes**

The studio was composed of several research and design phases. The first phase: "Situating the Re-Thinking – Systems and Processes," consisted of case study research providing the students with a knowledge base of the existing and emerging alternative prototypical approaches. Some of the following topics were explored:

*Research Topics*

- Prefabrication/Kit of Parts – Modular Components and Assembly
- Mass Production/Mass Customization Manufacturing Principals
- New and Sustainable Materials and Integrative Practices
- Innovative Parking/Drive-Thru/Drive-Up Strategies and Ordering Technologies
- Branding, Marketing, Social, Cultural, Political Contexts

**Sites in the Global Everyday Landscape: from Urban to Suburban**

The second phase of research and design titled "Sites in the Global Everyday Landscape – from Urban to Suburban" required the teams to utilize empirical observation. Through photography, diagramming, and animation, they analyzed existing sites, spaces, and building types within the Dallas Fort Worth area that were of similar size and program of *Chili's NOW,* as well as the given "prototypical sites". Through this investigation of pragmatic criteria, such as the relationship between cars and pedestrians, sites and programs; pros and cons of the "status quo" examples were discussed. In addition to examining the existing conditions, the teams also investigated examples of more innovative solutions, especially strategies related to creating difference within repetitive prototypical structures and sites. They examined examples within the Dallas Fort Worth area, as well as from other resources. Similar to the "status quo" studies, the teams listed the pros and cons of each. From here the teams regrouped and asked themselves: "How can these existing models begin to adapt to difference as well as create 'place' through contributing to the public infrastructure of the city?" Through quick speculative diagrammatic studies the students generated a variety of alternative layouts.

*Prototypical Sites*

- Stand Alone – Suburban parking lots in front of strip malls
- In-Line – Suburban strip centers
- In-Fill – Urban centers
- Add-Ons/Retrofit – Urban and/or suburban additions or retrofitting existing structures
- Mobile – Trailers, temporary structures, kiosks, roadside stands

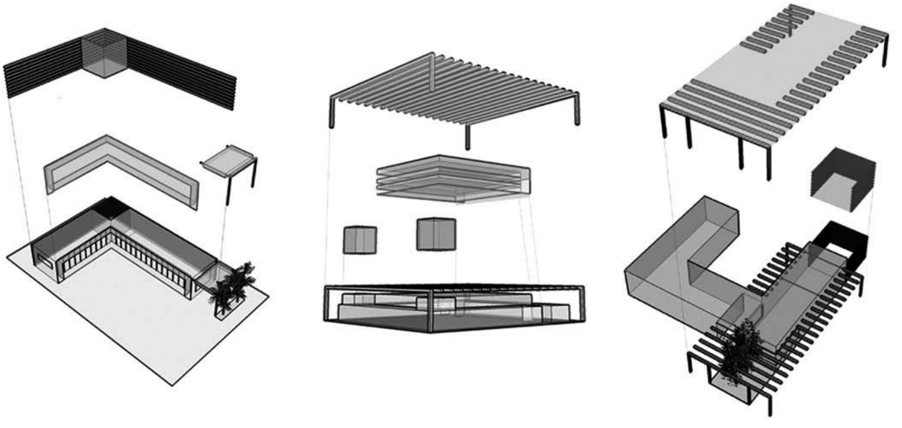

**Figure 1**

Images from Phase II

“Sites in the Global Everyday Landscape – from Urban to Suburban” alternative diagrammatic layouts of mass customizable prefab components and assemblies by students Jennifer Craddock, Alyssa Watkins, and Jason McDonald

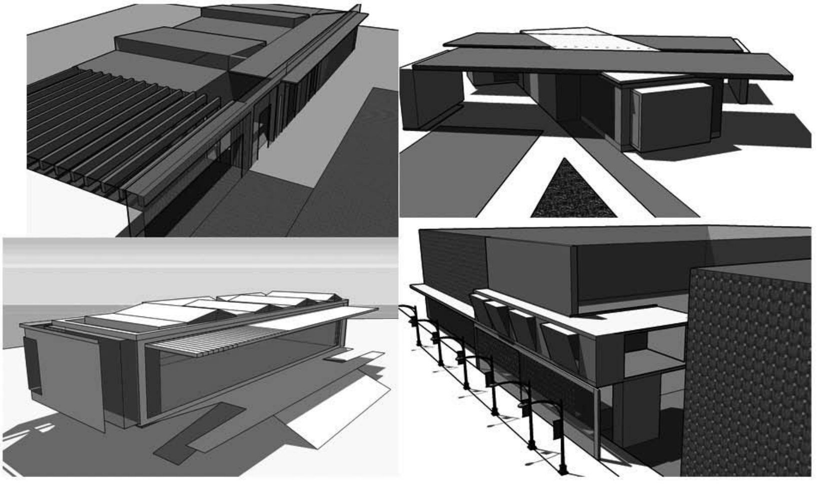

**Figure 2**

Images from Phase II

“Sites in the Global Everyday Landscape – from Urban to Suburban” alternative diagrammatic layouts of mass customizable prefab components and assemblies by students Tupali Kahumbe and Zachary Spillers

**Sites and Systems Scenarios**

In the final phase: "Sites and Systems Scenarios", the teams utilized their previous research and played out different sites and systems scenarios. The teams proposed customizable prototypical systems and site strategies that adapt to different constraints, such as site, climate, program, culture, material, manufacturing technologies, budget, aesthetics, and so on. For each "prototypical site scenario", (i.e. stand alone, in-line, in-fill, add-on/retrofit, and mobile), the teams chose a real site and city using Google Earth or MSN Virtual Earth. In addition, the teams made a point to exploit these differences through the site/city choices made. For example, the climate and cultural constraints are very different for *Chili's NOW Jakarta*, versus *Chili's NOW Anchorage.* Or the site constraints for *Chili's NOW Tokyo* may call for an "add-on/retrofit" prototype, versus *Chili's NOW Daytona 500*, where they may need a "mobile" solution. Ultimately the teams were asked how does their repeatable and yet customizable system adapt to difference, and yet still maintain the *Chili's NOW* brand, as well as create a sense of place within the global city? In other words, how is it "Glocal" – responding to local and global differences?

All proposals utilized principles of mass customization and CAD CAM technologies such as laser cutting and 3 D printing for conceptualizing and creating customizable components. These were also utilized in conjunction with more standard prefab components.

**Conclusion**

Most of the student's proposals were innovative in the way they adapted to difference, although some of them had allowed too many variables; thus creating too many options, and perhaps creating so much difference to where the prototype became unidentifiable as a *Chili's* brand. The challenge was how to respond to local differences and yet still maintain a global identity. Therefore, certain aspects of the prototypes should stay the same and/or still be recognizable as a brand, and yet still adapt to idiosyncratic conditions encountered on site. Perhaps not giving so many different cities and different sites would have lent itself to focusing on what should stay the same, or "fixed" within the prototype, and what should be different, or "fluid" as it is re-sited or resituated. The students had a tendency to redesign or reconceptualize the entire system as they encountered each variable. In retrospect, one may propose the prototype to be site-less in its conceptualization, and then once inserted into the various situations, begin to make the necessary adjustments.

In conclusion, this work is attempting to address relevant issues related to global practices today. Given that the vast majority of our built environment is comprised of prototypical architecture and spaces that we experience everyday, we need to critically engage the problems of "sameness", a problem that is typically inextricably linked to the prototype. Can we begin to design them with more specificity reflecting difference? And most importantly, this calling for specificity and difference versus homogenous "cookie cutter" prototypes, aspires to be more sustainable from many perspectives – whether it is cultural, ecological, social, economical, or architectural.

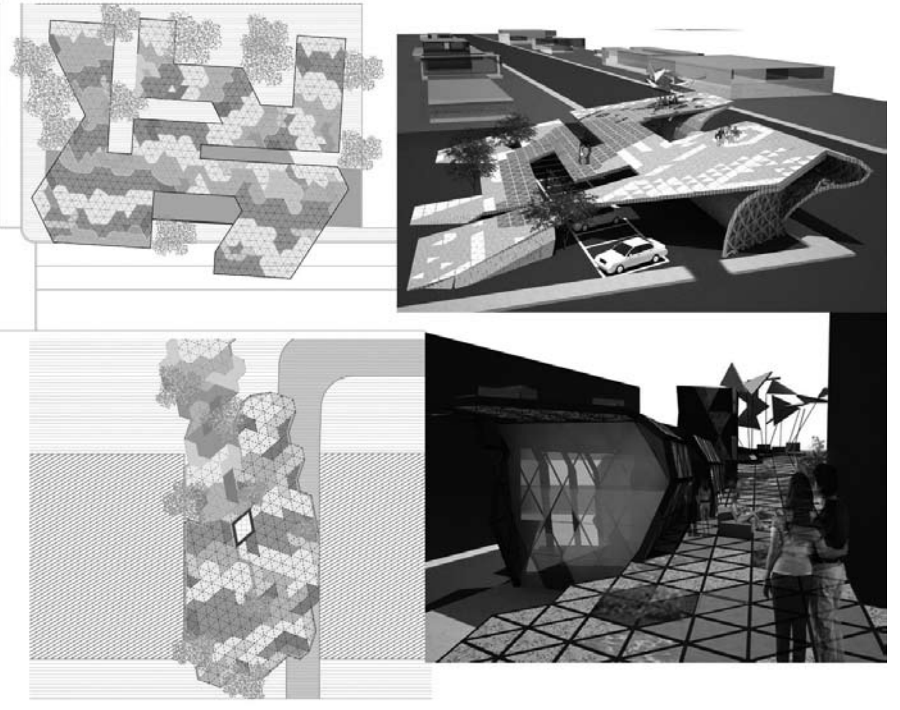

**Figure 3**

Images of final proposals for Stand Alone – Arlington and Inline – Detroit
by students Olga Herrero, Albert Navarro, Zeleste Ortigosa
(Customizable triangulated system integrates structure, skin, and identity through various reconfigurations and infill panel options. Proposal also incorporates other programs such as 'public' park/play ground and drive in theater in an effort to contribute back to the city and the public realm).

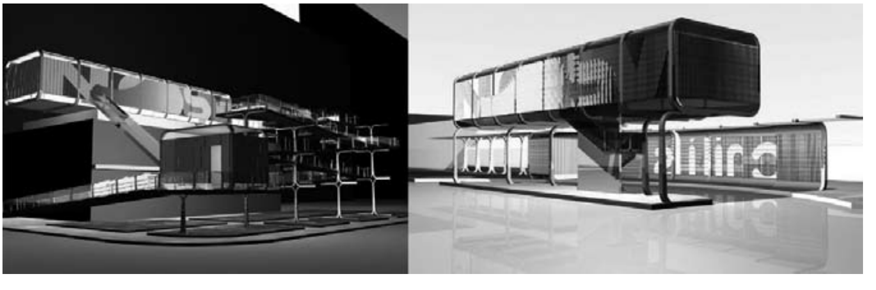

**Figure 4**

Images of final proposals for Inline – Houston, and Retrofit – Chicago
by students Kenneth Fitzgerald and Juan Rico
(Customizable rib structures and infill panels vary and reconfigure as per varying site constraints, climate conditions and signage options.  Proposal also incorporates other programs such as ramps and public eating areas, thus contributing back to the city and public realm).

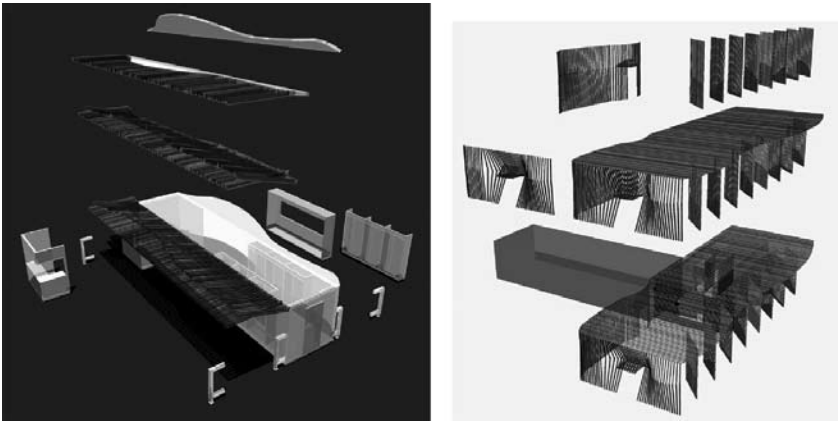

**Figure 5**

Images of final proposals for Infill – Rio De Janeiro, Mobile – Dallas Cowboy Stadium
by students Jennifer Craddock and Jim Wiese
(Repetitive and yet differentiated skin wraps and warps according to varying site conditions. Densities and porosities' of skin also adjusts according to varying sun, heat and wind conditions. Proposal also investigates generous residual space for gathering while open and after hours, as well as engaging the immediate sidewalks with "walk-thru" porches and outdoor seating).

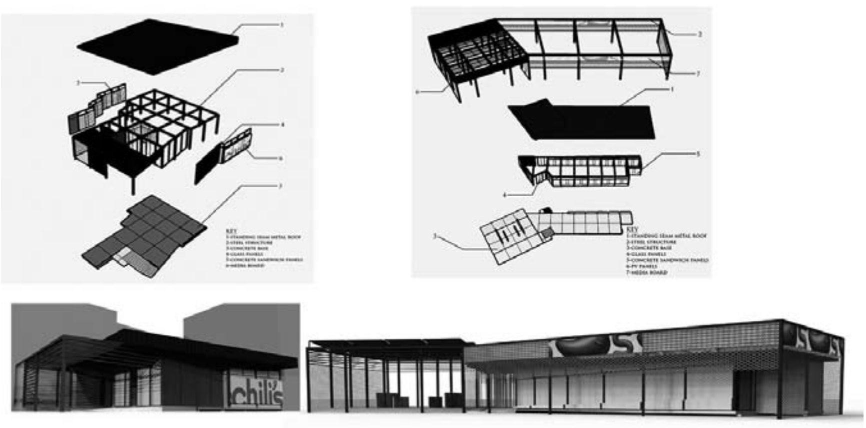

**Figure 6**

Images of final proposals for Stand Alone – Seattle, Infill – Edinburgh, Retro-fit – Tokyo
by student Kristen Thovson and Jason McDonald
(Multiple panel options allow for site and climate specificities as well as branding alternatives with integrated media surfaces. Proposal also gives back to the immediate site and city through providing public spaces with generous ramps and porches).

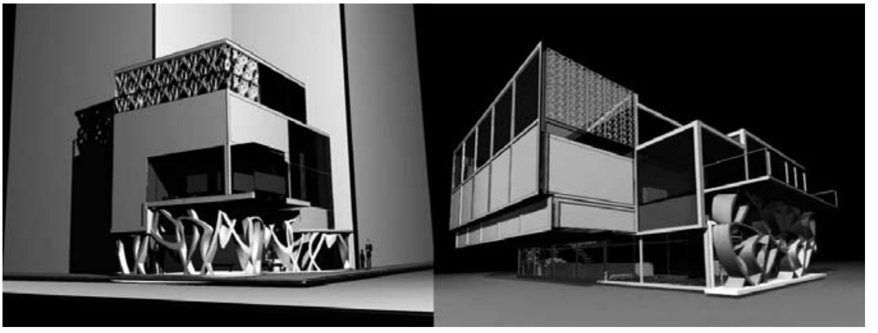

**Figure 7**

Images of final proposals for Infill – Venice and Retro-fit – New York City
by students Ana Cavazos and Alyssa Watkins
(Proposal utilizes an abstraction of the chili pepper as logo - from the scale of the screen to the scale of the inhabitable wall. The ground floor wall interacts with the public space of the sidewalk by providing interesting places to sit, lean and walk through).

## Notes

1 Crawford, Margaret, "Introduction to Everyday Urbanism".
2 Dunham-Jones, Ellen, "Seventy-five Percent".
3 Lefebvre, Henri, "Space: Social Product and Use Value".
4 Ibid
5 McTeer, Robert, "The Right Stuff: America's Move to Mass Customization".
6 Lefebvre, Henri, "Space: Social Product and Use Value".
7 Text of Andersen and Andersen Architecture describing new prefabricating and manufacturing technologies and practices for site specific construction.
8 Text of research conducted by KTA examining the new possibilities of sustainable, affordable and high quality design and construction afforded through new manufacturing methodologies and principals of mass customization.
9 Dye, Wanda, "Paradigm Shifts in Manufactured Architecture: From Standardization to Customization", "Mass Customization in Architecture: Heterogeneity in the Making", "Drive-Thru Architecture: Rethinking the Fast Food Prototype".

Harry Giles

# Prefabricated Construction using Digitally Integrated Industrial Manufacturing

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Harry Giles

# Prefabricated Construction using Digitally Integrated Industrial Manufacturing


## ABSTRACT

The paper describes research being carried out in relation to prefabricated high density affordable housing under a grant from the Partnership for the Advancement of Technology in Housing (PATH) and the National Science Foundation (NSF) in the USA. The objective is to demonstrate how a new paradigm for the conceptualization and construction of buildings can be conceived of as an entirely factory based process that creates advantages for construction through industrial systems technology transfer. Our approach is intended to transform design methodology through demonstrating how alternative construction concepts, using entirely pre-manufactured volumetric units, can be adopted. This involves digital modeling that facilitates parametric variations for creating customized prefabricated products from design conceptualization through to final product delivery. The paper discusses key areas under investigation in relation to a manufacturing paradigm used in the automotive industry that integrates virtual prototyping and industrial manufacturing systems. Our research explores a type of monocoque volumetric unit prefabricated in steel, which will be pre-finished as part of a modular factory-built approach using industrialized methodologies that will facilitate customized manufacture of a high quality energy efficient product for affordable housing.

The paper addresses the automotive industry methods of manufacture that have served increased automobile performance and economics through mass production for over a century. In stark contrast, the building industry and in particular the housing industry is still a century behind. It is suggested that a move away from tradition will require an industry wide initiative, just like Henry Ford led the way with mass production. By embracing the increasing sophistication and capability that digital technology offers, it is shown how digital tools are implemented towards mass customization in house design using virtual modeling in the context of a prefabricated manufacturing approach. This includes industrialized modular sub-assembly design, where the information on parts, assemblies and modules can be transferred to digital and robotic technology, as seen in the automotive industry, as well as achieving enhanced production efficiency through a 'supply chain' process, which is condensed. The paper discusses how these models for manufacture can be transferred into the housing market in order to revolutionize the cost and quality base of construction. Our research objective is to disseminate knowledge on this process, and showing how through integrated transfer of automotive technologies we can implement an industrialized fabrication process for mass housing, not previously known in the building industry.

A key focus of our evolving research and development is to enable mass customization or delayed differentiation through virtual prototyping that becomes the central organizing element for design. This transfers through to the supply and implementation of housing using industrialized production line manufacture of a product. The expected outcomes of this research and the conclusions drawn in this paper will demonstrate the means by which to achieve more accessibility to affordable housing for society at large and how through successful design integration and an industrial basis for manufacture will provide an adaptable set of affordable housing typologies for diverse demographic needs.

## INTRODUCTION

This paper shows how high quality affordable housing is being researched through an integrated strategy that combines socio-economic considerations with technological imperatives. Currently affordable housing availability and quality suffers due to obstacles that fundamentally lie within current design culture and construction that shies away from past stigmas. Current practice perpetuates a traditional style and construction ethic that continues to encourage urban sprawl, undermines progress, and blocks opportunities for affordable housing. Integrated socio-economic approaches to these issues together with technological innovations can make high quality affordable housing more accessible. These issues are being addressed in the author's current research in technological innovations in the development of industrially designed modular concepts for low-energy, multi-story, prefabricated, compact affordable housing. This work is being carried out under a grant funded by the Partnership for Advancement of Technology in Housing (PATH) and the National Science Foundation (NSF) in the USA, as part of a national initiative for promoting higher quality and value in housing through the implementation of effective technologies.

A key issue for the housing industry is the fragmentation among various industry stakeholders, with its communication impediments and slow adoption of new housing technologies [1]. Our research has been focusing on developing a new paradigm for housing design and manufacture that includes spatial arrangements and volumetric configurations, through to fabrication, delivery to site, and erection. This research proposes a 'revolution' in housing construction that is based on manufacturing being entirely factory based rather than site based. Although there are a number of companies that produce 'modular prefabricated' homes, throughout the world, including Toyota and IKEA, they have yet to implement effective manufacturing methods used in the car industry towards more affordable high density multifamily housing. Toyota appears to only pride itself in providing 'comfort and luxury' in houses in Japan. [2] , a typical example of their product is shown in Figure 1.

The steel-framed Toyota prefabs leave the assembly factory 85% complete; in half a day, the modules get stacked into place with a crane. The company offers various sizes and designs, with an average family home comprising 12 modules and costing about $225,000 [2]

**Figure 1**
Toyota prefabricated housing  example [2]

**Figure 2**
IKEA 'Boklok' prefabricated housing example [3]

IKEA 'BoKlok' homes are timber-framed buildings, almost entirely prefabricated. They are usually brought to the site on the back of trucks as pre-assembled units, with the interiors already fitted out. Each apartment is made up of two of these units, which are moved into position by crane. The typical BoKlok arrangement is an L-shaped, two-storey block with three apartments on each floor. [3] Again, these houses are targeted at the single family market and are limited in their application to low rise construction because of the timber structural framing.

In the USA prefabricated homes are generally single family and little more that assembling parts of a building under a factory roof (taking advantage only of the environmental conditions), but still practicing traditional construction methods. The industry needs to transform radically if it is to come close to providing the kinds of statistics that the auto industry is able to show in terms of cost efficiency and final quality of product. In addition, these developments in prefabricated home design and delivery do not address the most pressing need for good quality, affordable high density housing.

**A PRODUCT DESIGN APPROACH**

We are therefore developing a methodology for the application of technology to house manufacturing methods for high density, multi family affordable applications that readily integrate technologies related to social sustainability and low-energy consumption. A whole-house prefabrication concept integrates building services into the enclosure, similar to the design of automobiles. The enclosure is conceived of as an innovative hybrid monocoque (or unibody) metal skin enclosure that is stacked vertically to form multi-story, prefabricated volumetric housing modules. It minimizes the number of parts to be made for the structure and maximizes on its inherent stiffness as a uni-body both for transportation and final performance. The material components, enclosure, and environmental systems are integrated with passive energy systems to create a prototype for modern living. Society readily embraces the modern comforts and technologies of other industries such as automotive, aerospace and electronics, yet when it comes to homes, we continue to live on a contradictory cocktail that mixes synthetic and romantic notions of habitation. These issues are key factors that create barriers against effective

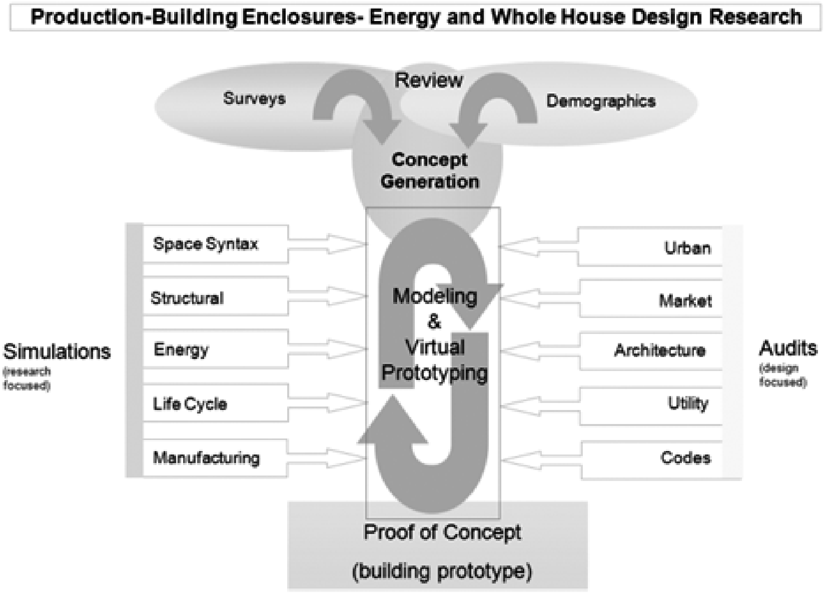



**Figure 3**
Product Design Development Model

improvements in the housing industry. New technologies continue to be 'attachments' that tinker around the edges of what could become an effective solution with universal acceptance for housing. Our model for design and delivery follows a Product Design Development Model that transforms traditional approaches to construction into a more product based industrialized design approach as shown in Figure 3.

In addressing the many and complex issues surrounding the integration of design with manufacturing, our research approach shown in Figure 3, includes the iterative process of simulation and audits towards a final proof of concept which include:

- Case Studies and Survey
- Demographics and Space Syntax
- Building Integration
- Prototyping – Virtual and Physical
- Structural Analysis
- Energy Analysis
- Life Cycle Analysis
- Manufacturing Analysis

It is beyond the scope of this paper to deal with each of the above topics in turn, but rather, the key parameters are discussed and examples are shown of the kinds of approaches and outcomes that are emerging from our research.

Unlike the consumer market that thrives on the latest in fashion and gadgetry, the housing industry is generally still steeped in the tradition of making homes that pander to some 'romantic' notion of what constitutes the 'appearance' of an ideal home. We see this being manifest even in the Toyota homes example described previously. This unrealistic 'dream' continues to be fed by home builders that continue to advertise the 'dream home' which is both inefficient and unsustainable. Even Toyota homes are not experiencing success in output, since they are trying to build 'traditional' and customized designs to factory standards and finding it hard to remain economic.

## INDUSTRIALIZED PREFABRICATION

What are the barriers for prefabrication? Unfortunately modular prefabrication in housing has always been synonymous with low cost, low quality, short term housing solutions, resulting in early deterioration of the building fabric and entire neighborhoods. The only real advances in home technologies have occurred at the high end of the market, where only wealthy home owners can afford to squander earnings in new niche technological applications and gadgets in support of a contemporary image and lifestyle, and at the same time securing prime land space available to only the financial elite. None of this is accessible to most of the public at large, let alone low income earners. Unfortunately these are the kind of products and projects that enjoy mass press coverage and continue to pander to architectural aesthetical aspirations. It is left to lowest common denominator and unimaginative home builders to propagate urban sprawl, the majority of housing stock on the market today. Residential homes represent some 70% of our built environment, and only a fraction of these are influenced by graduating and professional architects who might positively influence this domain. Clearly education on the benefits of a new genre of modern prefabricated housing concepts will be required and take some time to promote. In other industries revolutions have happened historically, such as the Henry Ford revolution – by designing an industrialized product that was more accessible to the masses, with a level of quality that sustained the value of the product and resulted in improved life style changes. We believe that this process can only be effectively accepted by the public at large by implementing model projects that clearly demonstrate the benefits of high density affordable housing advantages. Fortunately, there are some fine examples of this in the UK, constructed since about 1999, with projects such as Murry Grove constructed on an urban regeneration site over 5 floors with 50 apartments [4], including others like Raines Court[7], that demonstrate what is possible both architecturally and urbanistically using prefabricated steel framed modules. An example of this is shown in Figure 4.

We are taking a unique approach. Our basic principles for design follow those similar to industrialized car design, where the essentials of the functions and locations of the chassis, body, engine, wheels, windscreen, drive train, lighting, seats and doors are essentially the same. Where

**Figure 4**
Murray Grove project UK – prefabricated steel modular high density affordable housing [4]

**Figure 5**
Auto production line using automated robotics at the Hyundai car company. Source http://www.hyundai-motor.com/

the differentiation comes, is in styling. So design and manufacturing optimization takes place in engineering the main functional components to exacting tolerances with minimal waste, and many of the components are reused or reconfigured for different models. Most of the variants also come in the styling and some in the performance. Therefore we have developed a robust monocoque 'chassis' and 'body' combined, around which variants can take place. This allows our concept to be standardized and overlaid with a customized skin and function. The approach allows both variations (customization) during the design concept phase and later on, to be altered without impairing the building product. Taking a 'whole lifestyle' approach, we have configured a range of dwelling possibilities that cater for various demographics both at the inception stage, with potential for alteration as homeowner demographics change. Some examples of how design flexibility integration can alter with demographic changes are discussed and shown later in the paper.

## TRANSFER TECHNOLOGY MODEL

The car industry started by using traditional materials used in transportation at the time (mostly wood based) but very rapidly progressed to a new paradigm for using new materials and the methods of manufacture (steel) that best optimized on the car design performance, economics through manufacturing opportunities, and eventual disposal and recycling. The building industry and in particular the housing industry is still a century behind. A move away from tradition requires an industry wide initiative, just like Henry Ford led the way with mass production. With the increasing sophistication and capability that digital technology offers, we are now able to produce mass customized products, or as more appropriately stated in the manufacturing industry – delayed differentiation. This requires the production line to be specifically designed and installed to be both reconfigurable and accommodate design variants. Automated digitally driven robotics facilitates high volume output for minimal cost in automobile manufacture as shown in Figure 5. The production line is intense and requires significant capital investment based on projected and dependable production volume output. One of the key issues for industrialized modular prefabricated housing is the size of the market, to ensure consistent volumes of production to make the capital investment worthwhile in the marketplace. This has been an ongoing source of concern for fledgling fabricators attempting to enter the housing prefabrication industry. This situation will most likely continue for some time to come until the public at large and hence the marketplace for housing is seen as a type of 'consumer product' that is driven on the same basis as other industrially designed products such as automobiles. The building industry still has a long way to go to get close to industrialized manufacture. For example, at one end of the extreme, the car manufacturer BMW with 70,000 employees in 23 locations claims that they can theoretically produce 10^17 unique variations of a BMW 7 Series alone – far in excess of the possible production volume and the earth's population! Some other relevant if not staggering statistics about BMW car manufacture [5] are:

- High flexibility for customers - requests for chassis changes (including motor, color, and equipment) can be handled up to one week before assembly without affecting the agreed delivery date.
- Typically, up to 120,000 BMW change requests are realized per month.
- A typical BMW consists of 20,000 parts.
- Manufacturing precision is measured to thousandths of a millimeter.

All this for a unit price of less than $50,000.

One might speculate what it would cost to provide a simple house to the level of accuracy, customization and complexity of a typical automobile. The future does not bode well, considering that a simple affordable 2 bedroom home costs in excess of $100,000. However, to speculate even further, if housing construction had at least a small proportional set of comparative industrially manufactured features, it ought not to be too difficult to achieve similar choices, quality and output, still at a competitive price. So what are the barriers that prevent this from happening? This paper attempts to address some of the key issues being researched by the author and demonstrates how this is translating to a transformative approach towards the construction of high density housing in particular.

Kieran Timberlake (4) in their book titled 'Refabricating Architecture" observed how the car industry progressed from an assembly line that deployed one-by-one assembly of unit parts during the time of Henry Ford, towards modern modular assembly where parts and modules are managed automatically using the latest robotic technology. Modular production is best suited in an industry that thrives from a 'supply chain' process which is condensed, so that the best expertise is incorporated with as few parts as possible, which arrive at the point of final assembly in pre-contained modular units. Our approach towards designing a set of modular units, mass customized to the desire of the end user, is consistent with this approach in the automotive industry. We are convinced that by transferring these models for manufacture into the housing market, we can revolutionize the cost and quality base of our housing market. However, this will require a quantum shift in the conceptualization and appreciation of what a house represents in a modern world and begin to move away from traditional styles and methods of construction.

**RESEARCH CONTEXT**

This research is nearing completions of a three-year project. During the initial phase, our goals were to explore the possibilities of high-density mid-rise housing development using standardized modular prefabricated construction, influenced by the dynamically varying social imperatives that we see in a modern world. As part of this process, we conducted various research-based studios, with diverse faculty who are also part of the research team, to explore the issues listed Product Design Development Model in Figure 3. An initial study was carried out in the form of a design project, based on different sites of varying size, urban context and solar orientation. Based on the success of these initial studios, we developed several prototypical designs based on the guiding principles discussed in more detail in a previous paper [6].

A number of housing typologies were developed as models for technical exploration. The apartment layouts shown in Figure 6, were conceived of as an integrated solution that intersects with manufacturing, structural, environmental, spatial, urban and architectural goals and serve as a template from which parametric variations may be developed for other applications. The aim here was not to develop a fixed model that attempts to solve every aspect of design, but to construct well defined building blocks that become a template for stacking and reconfiguration, that links initial manufacture with final building layouts.

Our concept integrates technology with socio-cultural issues that encourages the diffusion flow. Our target areas for affordable housing are typologies related to multi-story developments that are a combination of low to mid-rise in height, or 3 story walkups to 7 story elevator blocks. In figure 7a, a prototype design is shown, which successfully incorporates all the relevant social and environmental features recommended by the author in a previous paper [6]. Figures 7b and 7c, show the apartment distributions based on the typologies referred to in Figure 6, with a demographic mix that caters for the needs of the local area and urban context.

**TECHNOLOGICAL CONTEXT**

Our research recognizes the housing industry's inefficiencies and fragmentation caused by the slow adoption of new housing technologies and we are promoting a paradigm shift for construction that uses industrialized manufacturing models and technology transfer in the design and procurement process, through to final climatic and environmental performance. The overarching objective of this research is to create a new way of conceptualizing technologically innovative housing design that integrates environmental, economic and social sustainability. This was conceived through a focus that:

a- Creates advantages for construction using factory-based manufacturing methods

b- Innovates construction concepts using entirely pre-manufactured volumetric units; and

c- Integrates low-energy/whole-house design and sustainable technologies.

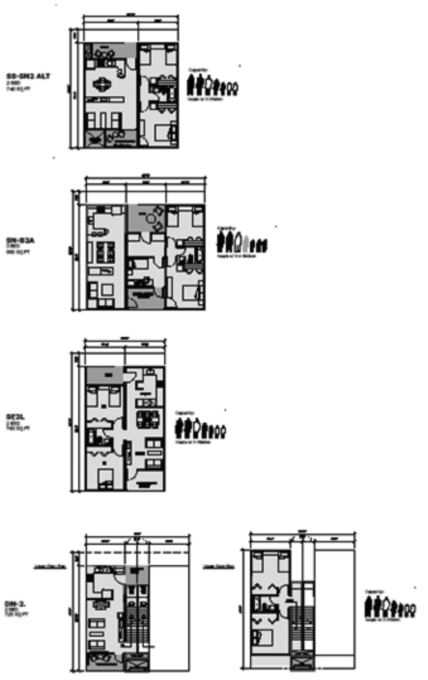
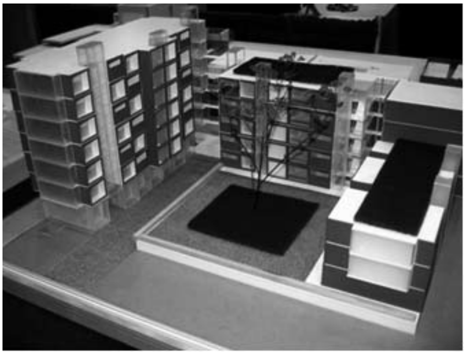
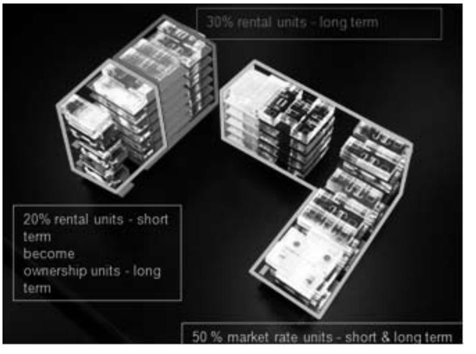


**Figure 6**
Representative apartment layouts used
in project modeling and technology integration





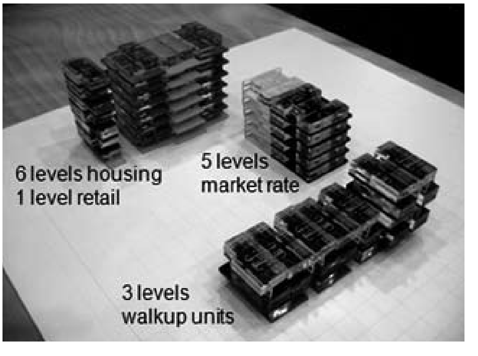




**Figure 7A**
Model prototype project
**Figure 7B**
Demographic distribution in the project
**Figure 7C**
Apartment unit distribution

We are attempting to shift the existing paradigm for housing construction, away from conventional layered methods that represent the majority of home building construction techniques seen on the market today. The applications for technologically innovative modular construction are not new, however their application in a new paradigm for housing is new and it is in this area that we are focusing our research and development.

With the increasing sophistication and capability that digital technology offers, we have evolved concepts that both allow increased efficiencies through an industrially produced product and allows for mass customization in house design, using a prefabricated approach based on virtual digital prototyping to test the process from concept to production line realization. Modular production and "supply chain" process are incorporated into a virtual building model that is used for testing variations, systems integration and manufacture within the Product Design Development Model described previously – similar to the automotive industry manufacturing system. Our approach toward designing a set of modular units, mass customized to the desire of the end user, is consistent with this approach in the automotive industry. We are convinced that by transferring these models for manufacture into the housing market, we can revolutionize the cost and quality base of our housing market. Existing models of so called "pre-manufactured homes" are simply traditional construction methods built under a roof adopting traditional stylistic modeling to entice the single-family home buyer. There is little that is industrialized about the process and even less which is innovative, resulting in a flattened set of "standardized" designs that eventually give the appearance of an on-site built "dream" home, but little else to offer than lower initial cost and consequent lower quality.

This paper will now address a few of the specific areas that relate to this focus in our research:

*1.0 Building Integration*

As part of an entire package for prefabricated modular housing, we have also addressed the role of energy consumption and generation in the context of an integrated design approach. This is achieved through the integration of passive and fresh air systems that provide additional benefits in reducing costs.

The apartment typologies shown in Figure 6 and Figure 7 incorporate a systems approach that integrates services, structure, manufacture, whole building performance and assembly. Each unit type is associated with a particular demographic application, whereas some units are able to serve multi-demographic categories. Therefore the system is able to be implemented at a global building scale that balances regional demographic social with residential needs. The system is also able to be reconfigured within the particular unit to allow varying time related demographic changes. Our research has so far identified the following key components that contribute towards an integrated strategy and have become the key features in the project design concept:

- fresh air distribution systems integration as part of the structural system
- creation of groups of 'parts' to facilitate sub assembly manufacture
- ability to achieve tight tolerances between steel components and units
- exploit non combustible nature of steel compared to wood
- exploit the high strength and stiffness to weight ratio in steel to economically achieve midrise construction heights
- utilize wall and floor decking as an inherently stiff monocoque system to resist lateral loads
- integrate a concrete slab for better acoustic, fire and environmental performance between units
- use sub-assemblies to allow customized design of modules and facilitate future flexibility.

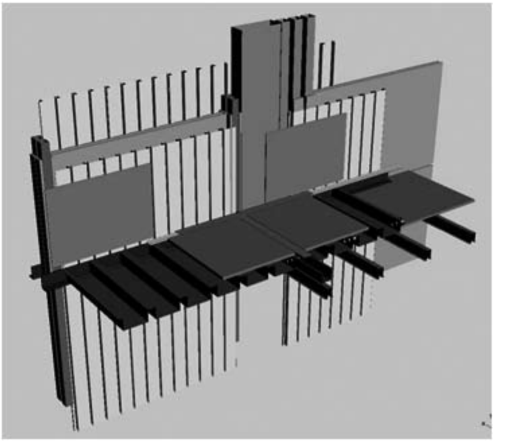


**Figure 8**
Modular building systems integration

A cutaway detail of integrated structural and enclosure components that are being incorporated in a virtual prototype of the building is shown in Figure 8, which is discussed further in the next section. The initial apartment layout logic system separates living modules from bedroom modules and integrates entrance niches and balcony spaces at the ends of each module. When combined with the access walkway balcony and in some cases internal stairways, these form the essential building blocks from which all apartment unit configurations are developed. Underlying the layout logic is the structural infrastructure that has been highly standardized, but at the same time configured on the basis of systems integration.

This layout logic continues to evolve and improve as the units are layered with various performance criteria and materials. This structural module with its ability for adaptation of components is becoming the underlying DNA that both organize the interrelationships between modules at the bigger scale and materials and fittings at a smaller scale. The structure is configured to fulfill not only a stability function but also an organizing framework within which services are distributed, openings are created and materials are attached.

Figure 9 demonstrates how a set of simple standardized modules can create a variety of apartment unit typologies, all based on an identical structural frame configuration.

The base structural frame also becomes the physical and organizing template for commencing manufacture. This is a significant conceptual leap in the integrated system and also a departure from conventional framing systems used in both traditional construction and as currently practiced in single family modular housing. The field for multifamily housing is still wide open and the modular concept developed goes much further in systems integration, even when compared to similar technologies already used in other countries such as the UK.

*2.0 Virtual Prototyping*

In order to better understand the physical interactions of some of the modular concepts being developed, virtual prototypes of components were developed as they might be conceived of for manufacture. This included modeling of structural systems to build a complete virtual building prototype in 3 dimensions for future manufacturing studies and implementation of production prototypes. A cutaway assembly is shown in Figure 10 that shows the development of integrated details for an entire living unit.

These graphics formed the basis of developing 3D parts and sub-assembly modeling for the building virtual prototype, by setting up modeling strategies as shown in Figure 11.

Systems coordination of parts and sub-assemblies are then hierarchally built up into units from modular building blocks. By using various layering strategies in CAD we have set up a system whereby selective building elements can be observed depending on the particular source of interest. For example, the entire steel structural system can be uniquely isolated, printed and bills of materials created using this process. In addition the virtual model is made up of individual 'parts' and 'sub assemblies' that can also be tracked in the management system, both during design development and for final production planning and processing. The design process pre-empts the manufacturing process through virtual prototyping operating as a building information model (BIM).

Our layering naming strategy broadly matches the "MasterFormat" 2004 [8] edition so that the naming systems will be easily recognized by builders and other professionals alike. This strategy is translated into a 3 dimensional virtual prototype that is continuously being developed using 3D solid modeling CAD software. The virtual model is more consistent with the currently established CAD norms in the industrial sector, to further support rapid changes for customization and reconfiguration of production lines. Versions for manufacture are being developed in collaboration with manufacturing partners in order to compare the home manufacturing process with established industrialized manufacturing.

Consistent with the modular assembly approach, we have developed building systems that are based on reconfigurable sub assemblies that will facilitate mass customization, hence breaking away from traditional building approaches. A sub-assembly should be removable as an assembly, and as such this has implications for the methods by which buildings are constructed. This is precisely what our modular concept is developing down to the smaller 'part' or 'component' level of detail – ie. Entire 'plug-in' sub-assemblies are designed to fit into hierarchical frameworks such as large openings housing door or window openings which are each in turn designed to fit a sub-assembly of door and frame or window and frame system. The entire wall subassembly of smaller component parts is then lifted into position to fit into the larger hierarchical structural framework as can be seen in figure 12 which shows a basic virtual 3D prototyping strategy that has evolved into a more complex configuration of sub-assemblies and parts as shown in Figure 13.

Virtual prototyping was expanded from the base module to the larger building unit assemblies and Figure 14a and 14b shows the various volumetric modules combined to create a variety of apartment units both horizontally and vertically, when fully assembled on site to form the entire building complex. Figure 14a represents a color coded separation of living units whereas Figure 14b, shows the actual completed assembly, showing how the units are indistinguishable exter-

**Figure 9**

A standardized kit of module assemblies provide various living unit configurations

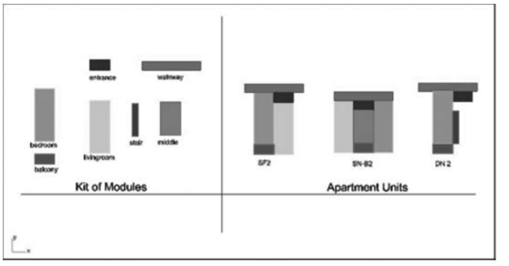



**Figure 10**

Virtual prototype cut-away of complete living unit assembly showing key elements.

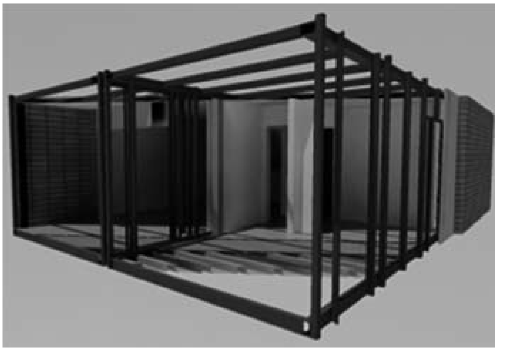
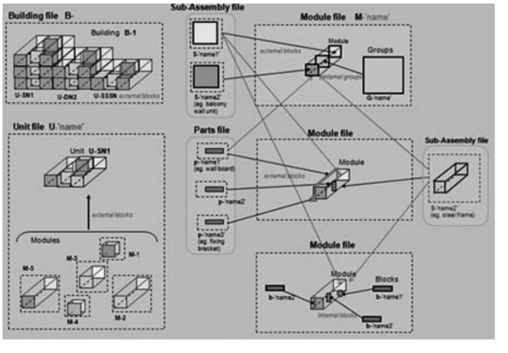


**Figure 11**

Virtual prototype modeling strategies



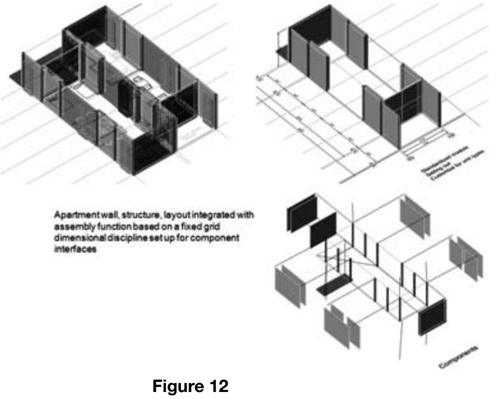




**Figure 12**

Virtual prototype component interface integration strategy diagram

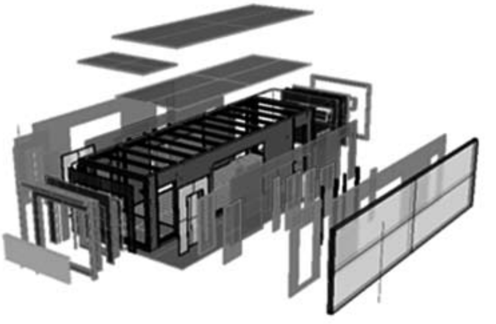


**Figure 13**

Exploded view of basic module into parts and sub-assemblies nally and form a coherent building mass, yet at the same time possessing the rigorous underlying discipline based on the prefabricated module configuration.

The virtual prototype assembly has also been successfully used to model a manufacturing process that is planned for a moving production line. We used this method to disassemble typical modules to their constituent parts and then to reassemble these parts as a series of sub-assemblies to study alternative possibilities for manufacture. One version of a potential assembly process is shown in Figure 15.

An outcome that is emerging from our systematized modular approach is that components and parts can be scheduled uniquely for manufacture, since the graphic building blocks used to make the virtual prototype will become the final item for manufacture. Since each part is uniquely modeled, referenced and dimensioned in the virtual model, they are also the final part that will be manufactured. Figure 16 below demonstrates the kind of hierarchical relationships between part, sub assemblies and module that underlie the expansion of the modular system into ever increasing complexity and variety.

This does not appear to be a difficult task and we expect that as these schedules are generated they will in turn begin to inform the production line infrastructure. As can be seen in Figure 11, small scale modeling grows from producing parts through sub assemblies to modules, which in turn become units and buildings. That is, the entire building assembly process is traced back to each individual part in the virtual model, so that the production method leads the design development. This might be an anathema to most of the architectural industry that considers design to lead construction. It is this kind of inversion of thinking that will need to take place, in order to fully implement a successful new paradigm for construction.

### *3.0 Industrialized Manufacturing*

A key objective of our evolving prototype development is to enable mass customization or delayed differentiation, all of which is founded in the virtual prototype that becomes the central organizing element of the entire design, supply and implementation of the home as an industrial product. As has been demonstrated in car and aircraft design, monocoque structural systems are more efficient in terms of strength-to-weight ratio and possess very high stiffness characteristics.

This is crucial for a volumetric unit that is proposed to be pre-finished, integrally with the modular factory-built approach, to ensure that the final finishes within do not suffer during transportation and installation.

Methodologies for manufacturing analysis that will allow for mass customization have been developed and are being combined with the virtual prototype described previously. `We have established relevant factors for analysis as it applies to modular prefabricated high density housing. The manufacturing of prefab houses is related to a variety of manufacturing issues such as component fabrication, assembly process design, assembly system configurations, module design, modular component design and supply chain structure. The use of outsourced sub-assemblies or components strongly affects housing-module assembly sequences and supply chain structure. The total cost includes materials, assembly, inventory holding, labor and trans-

**Figure 14A**
Color coded assembly of living units

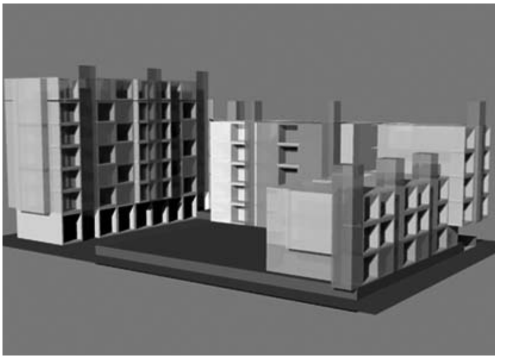


**Figure 14B**
Coherent assembly of living units showing unified composition of façades.

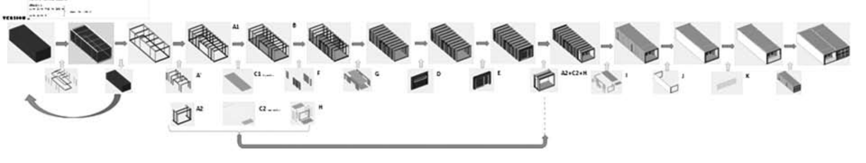
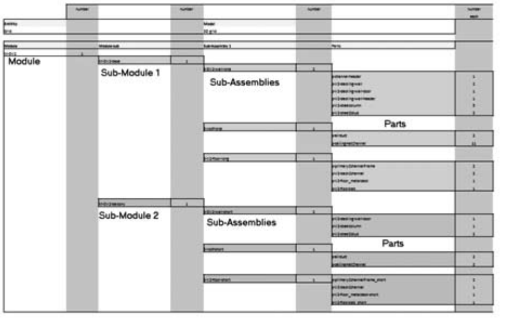


**Figure 15**
An assembly line reconstruction using virtual prototyping

**Figure 16**
Module, Subassembly and part hierarchy relationship



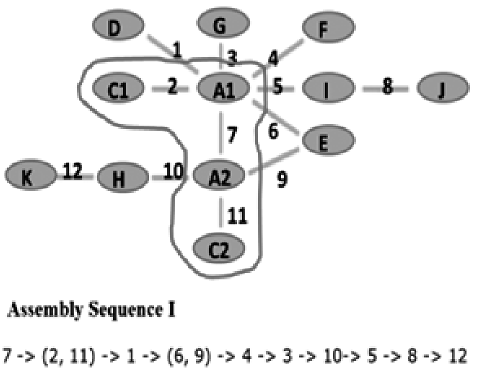



**Figure 17**

Sequence generation based on established relationships– 1st variant

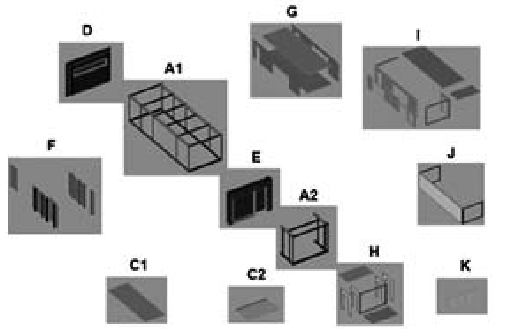



**Figure 18**

Module Decomposition into subassemblies

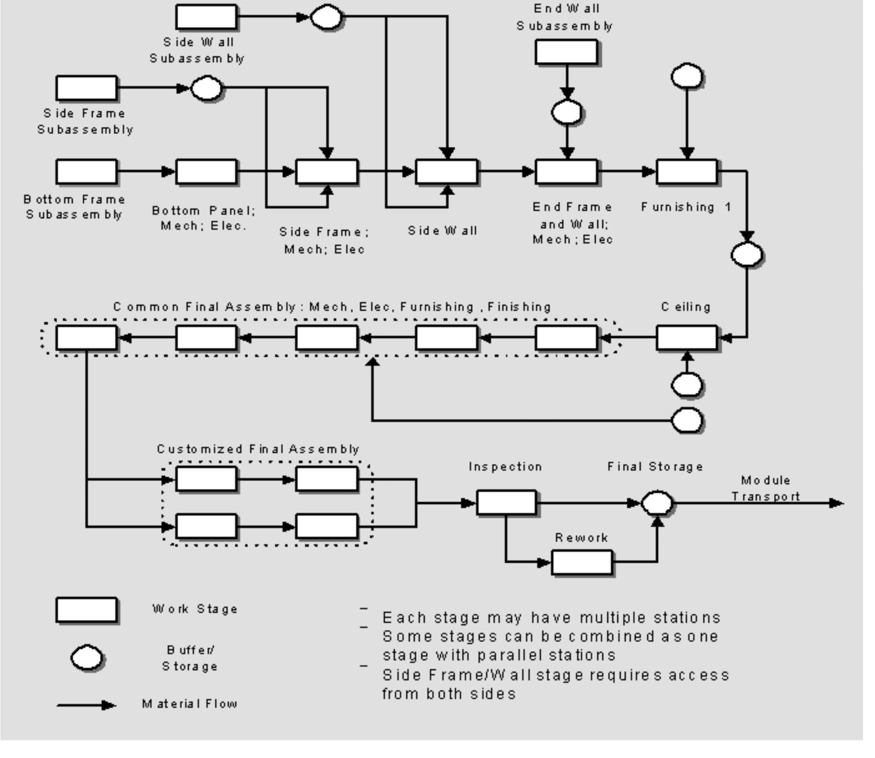



**Figure 19**

A model for a customized modular housing production line portation throughout the whole process. Because of the strong interrelationships between design, manufacturing and supply for prefabricated housing, the manufacturing process is being optimized in terms of the total cost and time spanning from the component supply to the final housing-module delivery.

We are pursuing concurrent design of subassemblies and assembly systems within a vertically integrated supply chain. The related decisions include component modularization, subassembly identification, assembly system configurations, and supply chain configurations. The technical constrains include available module fabrication capability, transportation, and construction site environment. The given conditions are construction time span, module variety, module demand, and assembly precedence relations. Mass customization concepts are in the process of being applied to subassembly identification and supply chain configuration to provide a variety of customized housing-modules.

An indicative system decomposition is shown in figure 18 which demonstrates the basis by which to establish a series of sequence generation scenarios as shown in Figure 17. Relationships are established from the module decomposition and are then recomposed in the most efficient manner that accounts for delayed differentiation (or customized manufacturing).

In conjunction with various proposed assembly-supply chain configurations and subassembly decomposition, a proper assembly system will finally be designed and constructed in collaboration with our manufacturing partnerships.

Traditionally, a fixed location layout or configuration has been used for building houses on site and in the factory. However, concepts of moving assembly lines and lean manufacturing can be applied to design the housing-module assembly system, similar to automotive and aircraft manufacture. Moving assembly lines can be very efficient in terms of productivity and a model for production is shown in Figure 19.

**Conclusions**

1. A suitable development model for future affordable housing design has been developed.
2. A detailed analysis of demographics has resulted in a variety of unit housing typology configurations, each of which can be customized.
3. This research is set to create new opportunities for affordable housing through the application of digital and automotive technologies.
4. A new prefabricated building product that can be customized has been achieved through virtual modeling that incorporates flexible living arrangements both for an entire building project as well as for more detailed layouts within the living units that allow for modifications over time.
5. Modular prefabricated construction, based on industrial design and contemporary manufacturing principles, will enable an affordable and better-quality product that takes advantage of the economies of mass and customized production procedures.
6. Key manufacturing procedures using virtual prototype modeling have formed the basis of alternative production scenarios that include supply chain management, production line design and facilitating the creation of mass customized products.

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# Joint Research

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# Joint Research

## Introduction

The question of detailing joints between manual and digital architectural construction is an area of practice which is still undergoing a search for formative principles within the established organizational strategies of the discipline[1]. The merging of digital and analog means of architectural production and construction should yield sustainable efficiencies, but contemporary buildings are rife with uncomfortable hybrids of both techniques resulting in monstrous juxtapositions[2]. Both literal and conceptual, the joints of this study are manifest in design processes, drawing, construction techniques, contracts, and architectural theory. These joints are of both technical consequence and aesthetic opportunity for integrated practice.

The specific significance of this research concerns itself with the impact of digitalization within an analog world of architecture and construction. The use of digital technologies in the design and construction of buildings is hardly new to architecture, but still architects struggle with managing the transactions between video screens and the handwork of construction. More specifically, the type of joint that this research focuses on is the joint between manual-imprecise construction and digital-precise prefabrication. How do we reconcile joining systems, how do we resolve the question of digital prefabrication when architecture is forever beholden to the messy differentials of mud, rocks, and excavation[3]? This resolute imperfection of the earth, where construction tolerances are measured in larger forgiving dimensions is juxtaposed with computer fabricated components with tolerances measured in millimeters. The joints mediating digital and analog components tend to be improvised and non-synthetic. How do architects mediate the different scales of digital and manual construction systems? Lines of aesthetic articulation can be delineated to join different dimensions and proportions, materials and systems; various joints can be constructed for the interplay of shadows and light, to allow for thermal expansion, to control water flow, and maintain insulation. The poetic quality of joints and the development of ornamental systems for navigating the different technical requirements of digital and analog constructions is lacking in both the theoretical and technical disciplines of architecture. What type of joint shall we use: exposed joints, articulated joints, hidden joints? What sort of tolerances do these joints require: millimeters, inches, feet? And how are those tolerances transmitted across systems? Methods of prefabrication and digital design offer myriad potentials for more efficient architectural practices, but a taxonomy of architectural joint strategies is needed to clarify architectural opportunities in managing the dichotomies of manual and digital concerns.







**SmartWrap**

Sidwell Friends School, Loblolly House from KieranTimberlake

Over the past several years, KieranTimberlake Associates in Philadelphia is a firm that has undertaken a path of research focusing on problems of contemporary construction systems and practices. One product of this research was a speculative wall system proposed for a museum exhibit: SmartWrap. The questions, problems, and provocations of the initial SmartWrap research is resulting in a complex evolution of KTA's prefabrication knowledge and has yielded practical architectural instruments which can be deployed into projects currently under construction.
While they have yet to wrap a building with technology impregnated PET (Polyethlene Teraphathalate)[4], KieranTimberlake have utilized a number of the construction principles tested in the SmartWrap exhibit. One of the most important principles, prefabrication, was explored in a fast-track construction project at the Sidwell Friends School. The compressed schedule drove the design of an enclosure system which incorporated performative elements in similar categories to SmartWrap: insulation, an electrical system, view, daylighting, and a rainscreen. Besides being a prefabricated façade system, the rainscreen detailing yielded an architectural grammar which became a formal language for organizing many other scales of the project including: site systems, thermal systems, daylighting systems, enclosure, and ornament. At a second project, a similar wood rainscreen language was used. However, at the Loblolly House the question of prefabrication was explored far more extensively: thermal systems were embedded into prefabricated floor cartridges, entire program elements – a library, kitchen, and bathroom were proposed as prefabricated systems of self-contained volume and infrastructure which were then inserted into the on-site framework. SmartWrap may not have yielded flexible, plastic architecture; but its conceptual and practical questions have yielded tangible implications for the design/construction processes and the built product in KieranTimberlake's practice.

**Prototypical Knowledge: SmartWrap**

The path to SmartWrap began with four questions: to what extreme can the technical attributes of a wall be pushed, what are expectations of enclosure systems, how can the design and fabrication of systems be expressed/represented in the articulation of surface detail, and what is the architect's role in the creation of products? The chosen vehicle for these questions became a mass-customizable wall with embedded infrastructural systems printed directly onto a substrate[5]. KieranTimberlake wanted to integrate the currently segregated functions of a conventional wall into a single composite. With the exhibit's conclusion they had not realized most of the technical means by which to produce a fully integrated infrastructural wall through mass-customized printing[6]. However, a number of the ideas about assembly processes and building tectonics were very successful. The idea of a film enclosing a building is asking a lot in terms of durability, weather, and cultural expectations, but the continuous wrapping of the enclosure system represented some success in terms of parts reduction and assembly. Additionally, the prefabricated structural system was beautiful and easy to design and build with in all phases of design and construction.

**Digital – Manual Joints: SmartWrap**

An additional question arising from the exhibit which holds potential for development of digital-manual technics might be the development of interstitial and mechanical spaces. Rethinking the configuration, orientation, or the densification of these systems has been an additional area of research by KieranTimberlake since the SmartWrap exhibit. Rather than looking to SmartWrap for new materials and composites, it is perhaps more useful to look for a revision of construction assumptions and building part configuration and composition.

With the exhibit over, the question for KieranTimberlake became one of how to incorporate the speculative thinking behind SmartWrap into their current projects. The main impetus to much of their research had been and continues in current projects to be the incorporation of design, fabrication, and assembly techniques which limit the time and cost of construction, reduce energy demands, and which result in new formal strategies for design and detailing. The specific SmartWrap criteria was generated by similar principles: reduce the struggle for infrastructure space by prefabricating as many systems as possible, streamline the currently segregated construction processes by reducing the number of hands and trades needed for installation and fabrication, and the incorporation of self-sustaining energy systems. These criteria have some of their most instrumental value when possible applications to practice are similarly focused around the development of theories of joints, prefabrication, and infrastructure. The problem of joining while inherent in architectural thinking, becomes more complex and requires more precision with larger chunks of building program. Besides keeping water out and maintaining thermal breaks, now mechanical and electrical components need to traverse the joints of chunks and panels. What type of strategy is necessary to maintain the integrity of all these systems? Voided joints, slipped joints, woven joints? What sort of tolerances do these joints require? Millimeters, inches, feet? And how are those tolerances transmitted across systems? For instance, the structure to skin attachment detail developed for SmartWrap was able to absorb problems of thermal expansion, material relaxation, and electrical transmission. The codification of these theories will be explored through two recent projects.

**Program and Joints: Sidwell**

Sidwell Friends School approached KieranTimberlake for help in transforming their fifty-year old middle school into a demonstration of their commitment to sustainability. KieranTimberlake increasingly see prefabrication as a way of adding another tactic to the discourse of sustainable design[7]. They assert that employee travel distances, construction mistakes, waste-recycling, and construction coordination are all potential streams of efficiency which can be managed more effectively through prefabrication.[8]

The client's goal was to renovate and expand their existing facilities into a LEED Platinum project which could contribute in a didactic manner to the school's Quaker principles. The sustainable program developed by KieranTimberlake with Greenshape LLC touched nearly every aspect of construction including: re-use of existing structures, water retention and filtration, natural ventilation, natural lighting, reclaimed or local materials, photovoltaics, and efficient construction processes.

KieranTimberlake started design by allocating space, program, and budget to these sustainable goals. However, this long list of technical criteria did not immediately address tectonic potentials for organizing a formal project strategy. The focus on achieving the Platinum rating had resulted in greater knowledge about sustainable systems and practices, but had not yielded a coherent design strategy – there was an assemblage of parts, but no joint strategy for holding it all together. This method of slow accretion of client information, consultant and research knowledge with many other factors is typical of KieranTimberlake's design method. One potential means was the exterior enclosure system which could act as a large scale joint system, a wrapper for the entire project. This seemed a useful strategy for KieranTimberlake since as a system, it would be located on both the new building and the older renovated building. They have constructed many projects using rainscreen principles[9] and continued to do so in wood at Sidwell. A prefabricated wall strategy was used as a constructive and a compositional tool to integrate multiple agendas including time, cost, and goals of sustainability. While the addition construction could happen concurrently with the school year, the classroom renovation could only take place during the summer break. These renovations included interior reorganization, but also new exterior cladding. The decision to fabricate the wall system off-site was made to alleviate the time-pressures on the interior contractors. The wall design included the usual systems of substructure, insulation, waterproofing, windows, and cladding; however, instead of multiple contractors assembling their individual components, the entire wall assembly would be put together in a shop, brought to the site, and mounted on the building as a complete assembly[10].

The wall panels seek to unify the different character of the existing structure and the addition, mediate their disparate massing, provide a strong urban edge at the sidewalk, and act as a transition element between the institutional and residential zones. Moments of conflict between the purity of the wooden skin and the proposed functions of the skin were exploited as opportunities for introducing syncopation into the skin pattern. These conflicts were typical detailing conditions such as downspouts, various shading orientations, and different structural bays of original and new construction. The new screen seeks a balance between the contradictory requirements of view and shade through the use of vertical cedar fins. Eventually these fins were absorbed from their role in solar performance into the enclosure plane of the facade. This is an agitated system, intentionally ambiguous: sometimes a fin is a joint, an edge, sometimes used for shade, sometimes a rainscreen; it may have both ornamental and performative roles. However, altogether they are subsumed into a rhythmic cladding which seeks to agitate perceptions of function and decoration. The unit of enclosure was defined both by the transport limitations and the structural bay on the building to be renovated at Sidwell. The strategy of working with the wall system was a direct application of the design principles from SmartWrap. The wall would be designed and constructed as a single component to be mounted in the field.

The vertical orientation of the fins, while seemingly in conflict with the horizontal bands of windows behind the rainscreen, is a response to the problem of joining a prefabricated series of panels. One of the concerns was tolerance of fabrication and tolerance of on-site assembly and a design strategy was needed which could mediate this joint. If a horizontal orientation was used, the sticks comprising the individual prefabricated panels might be difficult to align. KieranTimberlake considered deliberately misaligning the sticks from panel to panel, but this defeated one of the goals of unifying the formal quality of the elevations. Turning the sticks vertically provided a means of hiding the panel joints. The agitation of this system with varied depths and widths of wood planks became an ornamental system which served to synthesize the didactic nature of the construction with a compositional structure. This pattern of synchopated repetition can be seen in other project elements including: site, window, and ventilation technics.

**Joints and Assembly: Sidwell**

In terms of design constructability, the corner and end conditions of the panels needed the most resolution, so these were site-built instead. On the one hand this allowed for a degree of adjustment between the very tight tolerances of the prefabricated system as it was joined to the imprecise conditions of the existing building (tolerance was also needed within the system and the corners became the give point within the overall enclosure dimensional field). However, a different crew did the onsite work than had worked on the panels in the workshop. Although both crews were from the same contractor, there were differences of opinion between the two teams on the manner of construction and even with the location of insulation within the wall plane. Since there was no construction manager on the job, KieranTimberlake assumed the responsibility of coordinating the different trades. This separation of on-site and off-site work points to a larger problem of the hierarchy of detailed but specific knowledge within the trades versus deeper, comprehensive knowledge of the overall construction project. Trade-specific knowledge and the segregation of labor has not expanded to understand the interface with other trades and larger constructional issues. Prefabrication has also led to the combination of trades within a single building part. The prospect of reducing a building project to various fragments may hold promise for architects in terms of regaining some of the holistic control and imput for architects that are wanting in many architect-contractor-construction manager relationships[11]. Having all of the trades under the roof of one company may help to reduce some of the territorial issues of labor division and encourage a greater loyalty to the whole architectural project or at least a fabricator's specific fragment. The joints between these fragments will remain territories of potential design and control for architects.

**Program and Joints: Loblolly**

This project for a vacation home was seen by KieranTimberlake as a vehicle for testing some of their more intensive ideas about prefabrication. The office had proposed the idea of entire prefabricated bathrooms to several institutional clients but despite the potential of better scheduling and budgets, had not found a willing project. Their hope of attracting client interest in slightly more complex proposals seemed difficult without being able to point to some sort of recent precedent[12]. The Loblolly House is ideal in several other senses due to the remote site: problems with flooding, and seasonal temperature swings. These contextual complexities typify the less-than-ideal specifics any project might have and endow Loblolly with the legitimacy of difficult conditions which might be used by some as an excuse not to innovate. KieranTimberlake take the opposite tack; that with limitations come opportunities to question design and construction assumptions.

The application of knowledge gleaned from SmartWrap is probably most intensely developed at Loblolly House. The same aluminum structural system and many of the attachments developed for the SmartWrap exhibit are used here as an elevated structural cage. However, more to the point than materials, is the way that KieranTimberlake reconceptualize their design and construction process. Above the site structure of timber pilings, the entire building is prefabricated. However, instead of the usual prefabricated method[13] of making the entire building in one giant chunk, KieranTimberlake wanted to experiment with a different system of components. The house parts were designed as fully integrated and autonomous parts that have been categorized as scaffold, cartridges, blocks, and equipment. The scaffold system contains all of the connectors needed for its own assembly and for any attachments needed for the cartridges and blocks, and like SmartWrap, is put together with a single wrench. Floor and ceiling panels comprise the language of cartridges. This system has integrated radiant heating, domestic water, waste water, electricity, and ventilation ducts. Walls were constructed as panels with integrated windows, interior finishes, insulation, and the exterior wood rain screen. The term ‘block’ refers to entire rooms which were prefabricated. The bathrooms and mechanical room were fabricated with all systems integrated and lifted into place within the scaffold structure.

**Joints and Assembly: Loblolly**

Loblolly House represents the most intensive utilization of prefabrication by KieranTimberlake to date. They attempted to construct nearly every building component in the shop. While the overall effort is their most intensive prefabrication effort to date, there were similar issues as at Sidwell with the coordination of shop work and field work. The logic of craft was not always transferable among the different sites and workers.

As might be expected, one of the difficulties was reconciling the site conditions with the prefabricated components. While the shop work measured tolerances in millimeters, the foundation piles were two feet off in several instances. To reconcile this difference, a substructure was added to accommodate the difference between the two systems. Really a site joint, this condition became the operative architectural opportunity. It is chunky and thick, but represents one of the most pregnant possibilities for extending the tectonic grammar of prefabricated construction and questions of sustainability. How do we reconcile joining systems, how do we resolve the question of prefabrication when architecture is forever beholden to the messy differentials of mud, rocks, and excavation[14]? This problem of site joining was present at SmartWrap and is resolved at Loblolly in a similar manner: depth is accepted as a condition of this joint. But what are the other possible means: mass, reveals, grids, voids, gaskets, displacement, transference, suspension? Another similarity to SmartWrap is the cladding system as a primary source of tectonic strategy. In both cases, the orientation, fabrication, and assembly are intended to minimize joints. However, at Loblolly the system is not as prominent an influence on ornament, fenestration, shade control or other tectonic means since it is segregated and non-integral to the vertical wood rainscreen—an incomplete synthesis or perhaps a deliberate misalignment of technics and form.

**Conclusion: Digital – Manual Joints**

The operational logics that comprise the detailing of joints within architecture are myriad. As a consequence, architects still struggle to define the role of joints in mediating digital and manual construction within compositional strategies. KieranTimberlake is one office, which has sought to address the more systemic substrate of construction (whether digital or manual) by undertaking a path of research into potential techniques, and technologies that alter fabrication and delivery methods.

Their original research criteria (of which SmartWrap was just one vehicle) which focused mainly on questions of prefabrication and integrated mechanical systems has focused more intently on the tectonic strategies inherent in the different joint considerations required of manual and digital construction. These criteria have evolved through their development and implementation into numerous projects in their practice. KieranTimberlake came to this realization through the frustrations of their own practice: watching multiple trades competing for the same space and time during construction, multiple trades working on the same building parts, multiple site trips by various trades to field verify each other's work before returning to their individual shops to perform their own work. KieranTimberlake began to experiment with off-site fabricated building parts as a means of maintaining design control, improving the quality of the design and construction, and to reduce construction time. The methods for using technics as part of a compositional strategy have yielded tangible possibilities but are still undergoing continued refinement.

The knowledge sought in these projects share much the same goals of similar projects by Jean Prouve, Frank Lloyd Wright, Richard Neutra, Buckminster Fuller and many others. KTA seem close to a different synthesis of technique, technics, and composition with their use of digital and manual systems of production. The technics of architecture: the fire suppression systems, the transport systems, the lighting, the mechanical systems, and the sustainable systems can be looked to for tectonic design strategies. Their finished buildings and their details are not technically exhibitionistic, but rather formed of a mediatory process between performance characteristics, assembly, and form. At both Sidwell and Loblolly, the architectural form is the result of a dialogue between technics and composition. The finished buildings are not technically exhibitionistic, with their parts and story of construction on display, but rather a mediatory process between performance characteristics, assembly, and form. Not precisely didactic, these areas do point to areas of intense investigation in the development of a digital – manual detailing tectonic.

## Notes

1 *refabricating Architecture* by Stephen Kieran and James Timberlake, *Surface Architecture* by David Leatherbarrow and Moshen Mostafavi, *Component Design* by Michael Stacey, are among the numerous sources for reviewing the many historical and current methods of prefabricating architecture and of course there is no shortage of references for traditional construction techniques; however, there are few publications seeking to merge the dichotomy of these practices.

2 As in Marco Frascari's book *Monsters of Architecture*, this author also takes an optimistic view of architectural joints as opportunities for aesthetic and technical invention. See also Frascari, Marco; " The Tell the Tale Detail"; *Via 7*; MIT Press; 1984; pg 27.

3 A perpetual problem would be foundations, see an interesting proposal by Richard Neutra for a prefabricated and self-adjusting foundation system as mentioned in David Leatherbarrow and Moshen Mostafavi; *Surface Architecture*; MIT Press; 2002; p. 147.

4 PET acted as the substrate for the other enclosure components in SmartWrap. The other technologies included photovoltaics, batteries, an electrical matrix, organic LED displays, phase change materials (PCMs), and aerogel.

5 For a more detailed description of SmartWrap, see Wallick, Karl; "Making SmartWrap: From Parts to Pixels"; *The Green Braid: Towards an Architecture of Ecology, Economy, and Equity;* ed. By Kim Tanzer and Rafael Longoria, Routledge, 2007.

6 Much of the exhibit was fabricated using typical means of part by part manual construction in order to conform to the exigencies of the exhibit schedule. Deposition and roll to roll printing are common to the microelectronics industry but the problem of scalability is a hindrance to current development of a building scale proposal.

7 Refer to Stephen Kieran, James Timberlake; "KieranTimberlake: Present", *World Architecture*, 2005.

8 See online article by KieranTimberlake employee Kevin Pratt, www.kierantimberlake.com. Steve Kieran and James Timberlake also made this claim at the 2004 McGraw-Hill/Architecture Record Innovation conference.

9 For additional examples of rainscreen detailing, refer to East Stroudsburg, Shipley, Welles, Marks, Levine buildings in Kierant, Stephen and Timberlake, James; Manual: The Architecture of KieranTimberlake; NY: Princeton Architectural Press; 2002.

10 In a manner similar to another KieranTimberlake project, Levine Hall, panels were fabricated offsite with integrated shading, ornament, and mechanical components. See Kieran, Stephen, Timberlake, James; Chapter 6: Mass Customization of Archtecture; *reFabricating Architecture*; NY: McGraw-Hill; 2003.

11 See chapter 2: Role Reminders in the New World in Stephen Kieran, James Timberlake; *reFabricating Architecture,* NY: McGraw-Hill, 2003 for KieranTimberlake's view of the architect's role in this relationship.

12 I say recent precedents since explorations of prefabrication in architecture are numerous in the past century. Prefabricated bathrooms were proposed by Charlotte Perriand and built in the Arc 1800 and Arc 2000 apartments in France, 1975. See McLeod, Mary ed.; *Charlotte Perriand: An Art of Living*; NY: Abrams, 2003.

13 *refabricating Architecture* by Stephen Kieran and James Timberlake, *Surface Architecture* by David Leatherbarrow and Moshen Mostafavi, Component Design by Michael Stacey, are among the sources for reviewing the many historical and current methods of prefabricating architecture.

14 A perpetual problem would be foundations, see an interesting proposal by Richard Neutra for a prefabricated and self-adjusting foundation system as mentioned in David Leatherbarrow and Moshen Mostafavi; *Surface Architecture*; MIT Press; 2002; p. 147.

15 Refer to Wallick, Karl; "Making SmartWrap: From Parts to Pixels"; *The Green Braid: Towards an Architecture of Ecology, Economy, and Equity* for SmartWrap's ground attachment issues.

Jason Griffiths

# Pop-tech-flat-fab

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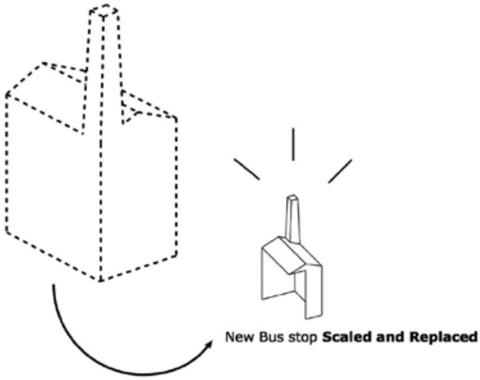
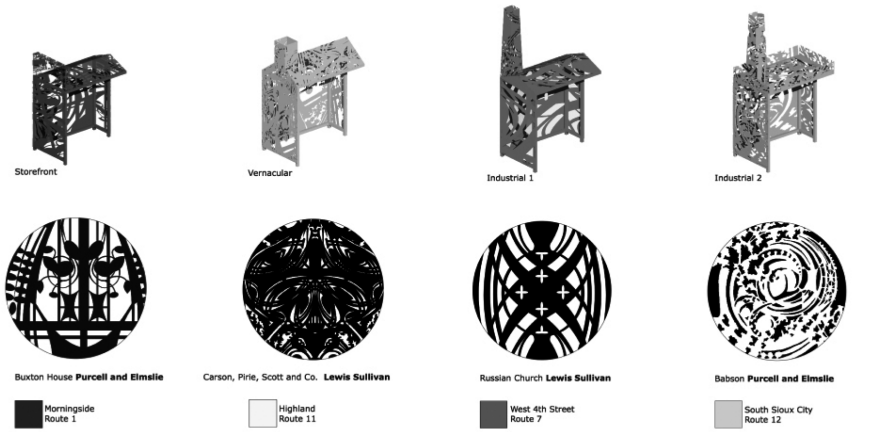
# Pop-tech-flat-fab

**Figure 1**
Completed bus stop and proposed multiple typologies

This paper for the EAAE / ARCC 2008 addresses the theme of simultaneity between the digital and analogue by examining the production of two projects. These are: a pair of prototype bus stops built in Sioux City[1] and a shade structure for downtown Phoenix in the USA. The conceptual basis for both these projects coincides with the question of how "phenomenon attached to a certain locality"[2] might be created through advanced methods of digital fabrication. Both projects offer an apology for rapid prototyping techniques applied to an understanding of "contextualism"[3]. Both projects are presented first as a contextual and symbolic response to an interpretation of "locality" and then re-appraised in technical terms. In both projects these technical aspects aim to advance not only the methods of physical production but also the transition of design methods to 1:1 fabrication. In the case of the Sioux City Bus Stops this idea is represented through an analysis of two-dimensional cutting techniques and developable surfaces. In the case of the Phoenix Shade project this idea is then developed through fully associative digital models. Together these projects attempt to accelerate the physical production of their symbolic and contextual content through a discussion on parametric modeling that allows an efficient production of a set of different permutations. By associating the symbolic/contextual with the parametric these projects suggest and alternative procedure to the traditional and prevalent trope of "digital architecture" and its co-dependence upon explicitly biomorphic, computational and quasi-naturalistic language.[4]




**Flat Cut**

The study of flatness[5] in architecture has a particular place within the expanding discussion of digital fabrication and its relationship to the built environment. This chapter suggest that while both the additive and subtractive methods of rapid prototyping have crucial roles to play in the design process it is the various scaled operations of two-dimensional CNC cutting that offer closer ties to conventional construction methods. The following offers a description of this method in the form of two bus stops that where designed for Sioux City Iowa in the summer of 2007. This text describes the background to the project and then presents the design and fabrication process as an aligned methodological transference from the model to full scale.

**Background**

In this case those formal and textural qualities were the main design priorities at the beginning of the scheme. The project was initially generated in discussion with a number of Sioux City public agencies that included the Chamber of Commerce and Downtown Partners along with key contributions from various steel production companies[6]. After the schematic design had been agreed the project was presented to the first year graduate students of Iowa States Architecture program as the focus for the summer session of the “Service Learning” course. The project was then developed in detail and constructed by the students under the guidance of the studio instructor. The whole course lasted eight weeks.

The key considerations of this design center on the role of the bus stop within the physical and cultural context of downtown Sioux City. As architect Nathan Kalaher points out the city has experienced ad ongoing “erasure” of the center between 1930 and 2003 and is still witnessing a depletion of its building stock[7]. Sioux City’s downtown areas are thinning out as former industrial warehouses are being demolished. This project responds to this context by mimicking those absent building typologies in quasi-historical scaled down forms. Proposals are presented as an apparition of what once existed and now reappears in a new form. The two we selected were “Smoke Stack Industrial” and “Storefront” which were chosen from a range of other reduced profiles. These forms where functionally adapted to the role of a bus stop to give shelter and provide good sight lines for the bus driver looking for waiting passengers (hence the bite out of the front left hand corner and missing leg). Another facet of this contextual reflection appears in the detail and decoration of the buildings elevations. All sides of the building are indiscriminately tattooed with abstractions of Prairie Style decoration that were generated from proximate sources. One appropriates from Steele / Purcell Elmslie’s Woodbury Court House and the other from Louis Sullivan’s Babson House[8] which were then collaged onto the form in a manner that externalizes and brings them to the close attention of the daily bus traveler. The final consideration in terms of these contextual links is the use of sheet steel as the main construction material. Of the remaining industries within Sioux City steel fabrication is one of it most vibrant. The city is often described as “Midwestern rust belt” claiming four large steel fabrication plants each making extensive use of CNC laser and plasma cutting capabilities. It is this aspect of the projects construction that forms the focus of this text and speculation on the “flat-cut” nature of mainstream digital fabrication.

**Likeness**

In part this speculation is based around the likeness between the design method and the fabrication technique. The key issue here is that the stock of the design model is manipulated in almost the exact same way as the full-scale stock. The consequences of design decisions can be more effectively simulated especially when full-scale stock sizes are replicated at smaller scale and with a similar material. This relationship cannot be applied to the additive process of the three types of 3D printers wherein the full scale construction method is drastically different both in terms of the material and in the manner in which is cast. This may be contested. At present professor Behrokh Khoshnevis is producing a 1:1 3D printer designed to produce concrete buildings called the "Contour Grafter[9]. However the issue of digital fabrication in architecture can be roughly categorized in two ways: Those that we can use today and those that we cannot. While both aspects of this discipline require extensive consideration in architecture it is the former that is focus of this paper. The following offers a detailed account of the construction process evaluated in terms of this "likeness" between design activities and method of production.

Pattern

The final arrangements for the external patterns were agreed after a lengthy process of trying alternatives. These patterns were generated from photographs and hand drawings of existing Prairie school designs. Here the issue of what constituted "localities" became an issue of contention among the class and with the clients. While the students had been encouraged to base the pattern on the contextually familiar language of Midwestern Arts and crafts they had also been encouraged to re-appraise this language in terms of contemporary iconography. This study took the form of an assimilation of images and graphics that portrayed Sioux City's current economic and industrial base i.e. cows, computers, steel and so on[10] (See Fig. 2). However the consensus amongst the clients and the students was that the sense of estrangement here departed from what was generally considered to acceptable within this context.

The range of alternatives (sans contemporary iconography) were then quickly tested by scanning these drawings as black solid shapes on white background and autotracing them in Illustrator to produce a set of polylines. These lines then formed the basis of the scaled down laser cut models. This process allowed us to quickly test the levels of transparency and topological continuity of the panels. The "autotrace" command could be used to produce a filled surface that can be moved around to test its integrity both as a digital model and then as a laser cut panel of the model. The method was used to analyze all the surfaces and make sure that all patterns held together. From our various choices we produced a number of models (in addition to the texture mapped renderings) used in presentations to the clients and fabricators and upon which we made or final choices. These illustrator drawings served to initiate one aspect of our discussions with both State Steel and Missouri Valley Steel on the problems with laser cutting. Initially it was hoped that these autotraced drawings would go straight to the fabricators for the final cutting although when the actual cut times where simulated using the companies NestPRO software they were considered to be too long. This testing process allowed us to get closer to the most efficient method of line quality and to iron out any unnecessary pause point during the laser cutting process. It transpired that the best line production would be an Autocad polyline that was generated from initial spline drawings and then converted to a polyline. In addition to this all acute angled junctions needed to filleted with a radius of no less that .02 inch in order for the laser cutter to cut the junctions without burning. The final cutting including the panel profiles had a travel distance of approximately 4000 ft at a rate of 100 inches/min with a total cut time around 8hrs for all panels.

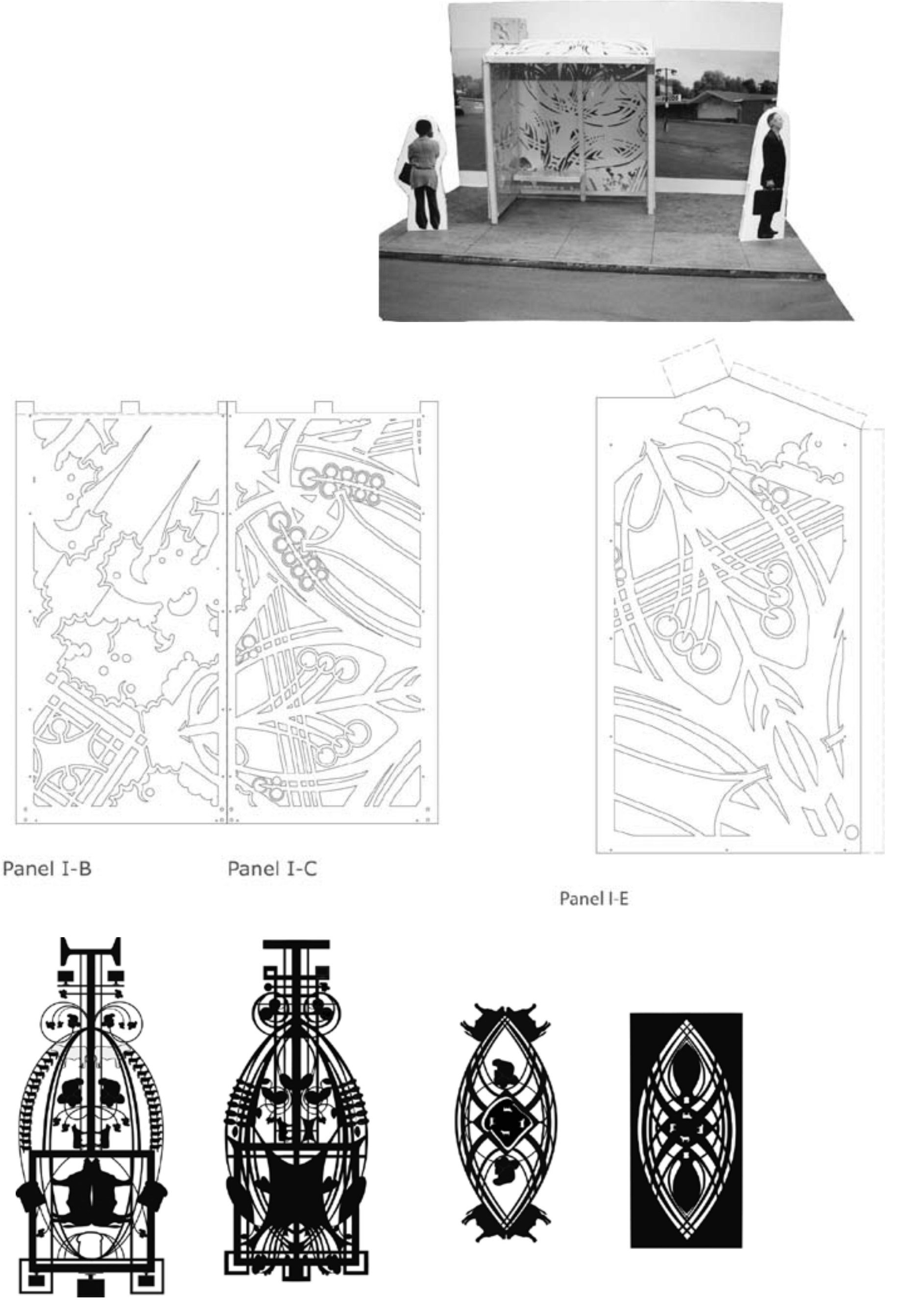
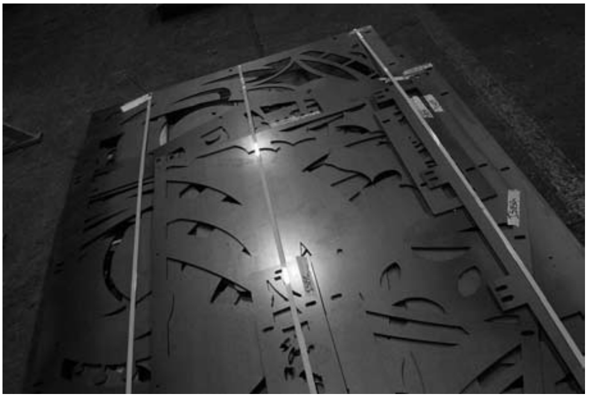
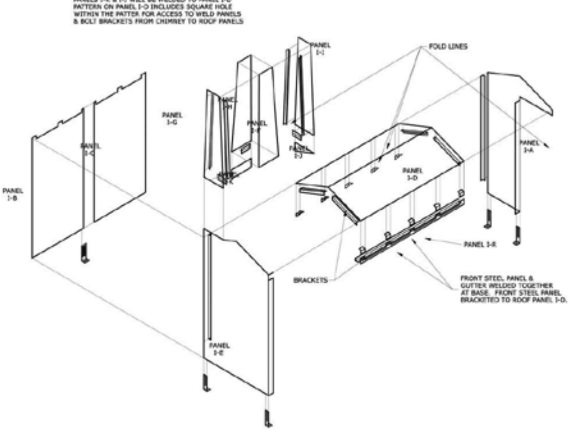



**Figure 2**

Contemporary iconography inserted into Arts and Crafts decoration.




PANELS I-K & I-J WILL BE WELDED TO PANEL I-D
PATTERN ON PANEL I-D INCLUDES SQUARE HOLE
WITHIN THE PATTER FOR ACCESS TO WELD PANELS
& BOLT BRACKETS FROM CHIMNEY TO ROOF PANELS
PANEL I-I
FOLD LINES
PANEL I-G
PANEL I-C
PANEL I-F
PANEL I-J
PANEL I-D
PANEL I-A
PANEL I-B
PANEL I-R
BRACKETS
FRONT STEEL PANEL &
GUTTER WELDED TOGETHER
AT BASE. FRONT STEEL PANEL
BRACKETTED TO ROOF PANEL I-D.
PANEL I-E


CINCINNATI

The issue of flatness became apparent again when we began to work on structural alternatives. Both steel companies advised us on the appropriate dimensions for their steel supplies that were principally to do with the nominal thicknesses, grain direction and overall dimensions. However the maximum steel sizes were ultimately conditioned by the 7x9 bed size of the laser cutter. All panel sizes needed to be within these proportions or capable of being efficiently nested as multiples within these proportions. Again this was something that we could simulate quickly on the laser cutter as save fabrication time. However these considerations had even greater effect on the structural solution of the project.

(Initially the designs had been based on a frame and panel system that was generated from studies of existing aluminum bus stops. This meant that the panels could be thin and non-structural. However we began to think that this might have a limitation on the longevity of the proposal. After our initial proposals to the Chamber of Commerce and open session of Sioux City Council we were encouraged to develop them as prototypes for more stops and other cities within the region. Additionally the steel companies were suggesting that they could be a flat pack system that could be delivered and assembled locally. As a consequence we changed the structural system to a folded plate method and made the decorative panels integral to the structure. The new system was to be entirely cut from sheet steel and connected with brackets. The panels were connected through tapped holes that were secured with 1/2'" dia. #20 threaded stainless steel hex-headed security bolts. This system required further analysis of the topological continuity of the panels and their lateral strength that was in effect a form of cross bracing disguised within the pattern. Additional strength was generated from the right angled folded plate panel ends and in the pitched roof form. In both cases all two-dimensional laser cutting needed to be done in advance and that those patterns needed to have a solid border along the fold lines. Once they were laser cut they then folded using a 200-ton NC press brake for accurate bend angles. Panel sizes also needed to respect the brake opening and accessibility issues. As the brake is predominantly used with steel these issues translated back to the design models and simulated with the laser cut chipboard model panels.

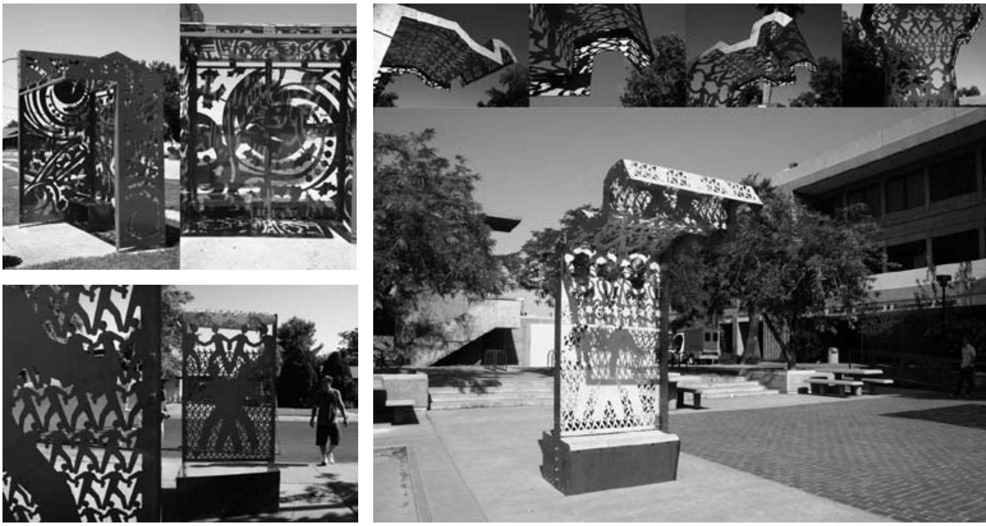
The preference for the flat pack version was also conditioned by the painting options.

At one point during the transition to the flat pack version we had considered a fully welded version. This proposal had more of a "one off " quality to it but was considered to be a safer bet both structurally and in terms of avoiding the complexity of designing and positioning the threaded holes and corresponding slotted holes. This version would then imply that the welded whole would have to be sprayed in an auto body shop by hand and not without some difficulty (especially within the chimney on the smokestack version). In effect this meant that the bus stops were considered more as artworks than a system for potential mass production. It seemed that, for pedagogical, reasons it was important to pursue them as a hybrid of a customized and mass produced system. This was furthered by the encouraging support from Sioux City Council for further versions. This issue extended to the painting options.

Our second alternative for paint was through a company called Frisco who have a manufacturing facility also in Sioux City. A large proportion of their work includes the mass production of components for age equipment that includes an extensive powder coating facility. The design of the flat pack bolted version was also influenced by this system and essentially aligned with age equipment component production methods. In addition to the panel size restriction of the laser cutting bed we were also restricted by the size of the 5'x102" throat of the shot blasting booth, the charging and spraying booth and the infrared heating run all of which were arranged in sequence along a hanging conveyor system. At one point we had been analyzing the possibility of getting the fully welded version through. However this was restricted by the booth throat area and also because this painting system was most effective on objects that had no hidden or internal faces. Therefore our pre-assembled pieces could be more effectively painted using a system that was designed to provide a specification that would withstand all weather exposure. In this respect the most vulnerable parts of the project were the sharp edges of the pattern in that the paint would thin along the edges. This problem was reduced by the shot-blasting phase of the painting, which would effectively round these edges giving a more even coverage. This alignment with the industrial process even extended to the paint finish and solved our anxieties about the right color. Although Fimco's were happy to source color options for us the plant mainly ran on bulk cans of stock ag colors of black and the emergency colors red, yellow, green and blue. Frimco's spay schedules are arranged around large batches of components of the same color. We felt that these colors were especially appropriate not only for production reasons but also because they would have some contextual link to the agricultural foundation to Sioux City. The built versions were the blue and the yellow although future versions would incorporate the full range of colors.

**Parametric versions**

Initially each bus stop was to be a unique reflection of its position within the city[11] and as a consequence built as a "one-off". The next phase of this project considers a set of variations each based on the idea of "absent typologies" (for example a house with a chimney and a warehouse). Subsequently however clients asked for a developed proposal for multiple variants to replace existing bus stops throughout the area. This presents a direct challenge to the notion of mass customization and how it is to might be achieved through parametric modeling software. This development in the project represents one version of the much wider problem of the move from conventional methods of design production and fabrication to fully associative digital modeling and rapid prototyping. The essence of this question lies in how these software environments deliver projects of comparable quality to those that are mass-produced while retaining their individuality. Furthermore can this diversity be delivered without excessive increase in design, information production, fabrication, delivery and assembly cost? (i.e. what is the point at which it "touches the ground"[12]) Working both with the steel companies and Fimco gradually pushed the project in the direction of the flat panel system. The realization of this project became more conditioned by industry standard production techniques. Part of the reflection of this project also considers the way in which the design process might further the notion of mass customization



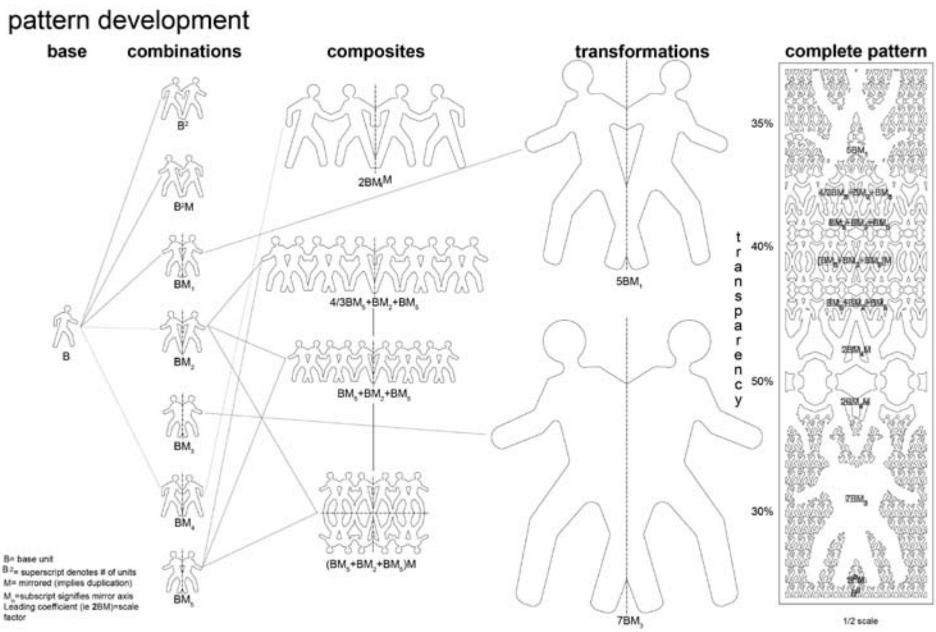



**Figure 3**

Permutations of “Cross Now”

while retaining a practical understanding of its effect on production information and fabrication methods. In this respect it is the earlier stages of the design that should be considered more widely in the manner in which it incorporates methods of digital morphogenesis. While the Sioux City project was not in itself developed into a parametric environment these considerations did have direct bearing on the subsequent project for Phoenix “Pocket Shade” project.

**“Cross now” Context and symbols**

Like the Sioux City bus stops this project began with a symbolic interpretation of the context. In this case elements of this context were: the generic condition of a typical downtown intersection, a framed view of the city skyline and the isotype figure of the “cross now” symbol for the traffic light. These cultural aspects of non-specific place are considered in relation to the functional question of providing shade for pedestrians in one of the hottest climate within the US.

Each corner of a typical Phoenix intersection presents two alternative aspects towards the city when waiting to cross the road i.e. north and east, north and west, south and east and south and west and each orientation present a particular skyline. The project responds to this skyline by mimicking its silhouette in an offset thick line that becomes the top of the shade/cantilevered structure. While the nature of this profile is largely an aesthetic device this aesthetic is arranged a marker of both a place and a time within a rapidly developing downtown environment. In the future this profile will act as register by which the public will be able to calibrate physical change within the city.

The second interpretation of “aspect” within this scheme is considered at a more local scale of the road width and crossing time. Each structure is arranged to face east west (reducing the profiles to either a north or south orientation) to provide as much shade as possible from the lower east-west sun). This vertical section of the shade provides protective screen for pedestrians waiting to cross the road and while watching the traffic lights and cross indicator. The project responds to this view by altering the percentage transparency and nature of the perforation of the screen to suit eye heights and sightlines for the pedestrians.

This aspect of the project was combined with the “prospect” of the building as a marker and pause point before crossing the road. Part of the perforated/ laser cut cladding of this project is then arranged to act as a supergraphic that describes the buildings implicit function through the larger isotype profile of “cross now” figure. This symbol was also multiplied at small scale to add a symbolic reading to the function of shade described above.

Both the screen and the profile offer separate challenges when considered in terms of the parametric model used to design and manufacture this building.

**Screen**

While this screen is subject to a more predicable set of constraints these constraints vary slightly from site to site. Even within the most generic and repetitious street layout each corner has its nuances and particularities. In each case the sightlines across the road will be different and the provision of shade affected by the immediate physical context of trees and building. The specific of each site give rise to specifics of pattern which then needed to be efficiently reproduced. In order to do this each pattern was generated though a set of geometric transformations that were then given a simple code e.g. 4/3BM5+BM2+BM5 etc (See Fig. 3). While this code has not, as yet, been processed as a script its rational geometric sequence can be use to accurately describe desired levels of transparency shade and opening profile.

The second aspect of the parametric quality of this project concerns the structure and its relationship to the skyline and the site. In order for these skylines to be quickly altered and quickly converted into production drawings the project had to be generated through one fully associative model that could allow each desired variation. We considered various software packages that allowed us to make the basic shift towards fully associative solid modeling all of which were based on the Parasolid modeling kernel eventually settling on Solidworks. The nature of the project orientated us in the direction of product design software and in particular programs that are geared towards sheet steel manipulation and folded plate geometry with associative hole pattern functions and bend type modifiers. Additionally it then provides direct methods for fully documented production level drawings that translated to NC bending and laser cutting software applications. In effect Solidworks was used to unfold our three-dimensional model and generate dimensioned cutting patterns with all hole and bending information including bend factors, tapping information and bolt schedules[13] automatically included. Each permutation of skyline could be quickly generated by manipulating the underlying sketch according to the desired profile.

This development also affected the relationship between the design activities and the steelwork fabricators. While it was more economical for the students to unfold and dimension all the drawings themselves the fabricators technicians were equally willing to do this. By using industry standard software the technicians could quickly analyze the proposal for any design flaws and fabrication problems and quickly amend them prior to fabrication. These areas of improvement mainly concerned pressbrake access and steelwork stock sizes. Our fabricators[14] would have been equally satisfied with a fully formed three-dimensional Solidworks model that they would use to provide their own orthographic cutting patterns. In most cases fabricators will customize bend deductions within software to suit their particular machinery. While Solidworks encourages designers to do this in-house it is only really effective if they have a close working relationship with fabricators and an intimate knowledge of their machinery. This is also often an economic decision on the part of the designer and based on the relative rates for in house technicians compared to shop technicians[15]. It has the additional benefits of allowing the fabricators to compose drawings directly through nesting programs and according to their current stock availability improving cost and efficiency.

Similar aspects of the cutting procedure also had an adverse affect on production time because we used two different steel thicknesses i.e. ¼” for structure and 20 gauge for cladding. This implied two different cutting power settings for the laser cutter[16] and therefore was cut in two different sessions. On reflection this procedure would have been more efficient if the design had been one gauge steel and fully composed as a folded plate construction system. This disparity

of steel thickness would also have an effect upon powdercoating times as both shot blasting times and heating temperatures also vary according to steel thickness.
A similar reflection the disparity between the pattern cutting drawing and the Solidworks models cutting drawing also reveal areas for improvement. Despite our move to full associativity these aspect of parametric modeling still remain as separate processes in the production drawing stage. While we found that we could make improvements to the sketch-to-scan-to-cutting process[17] to eradicate the problem of spline curve incompatibility with NC output applications we could not include the perforation cuts directly into the Solidworks file. Generally the Solidworks file would be arranged to have a solid sheet of steel to establish the general arrangement of the perforated panel and then the pattern would be inserted at the end and directly into the fabricators nesting program as a DXF file.

This text suggests that an effective use of parametric modeling programs would enhance the role of “digital morphogenesis”[18] as the alternative to the traditional duality of physical models and orthographic drawings. The alignment of scaled and full-scale laser cutting fabrication would then ensue without drastically changing the effect of the final outcome.It explores aspects of mass customization and the potential role of sheet steel parametric modeling software in producing further variants of a basic form. It reflects on further improvements to the design process with particular consideration of the morphology of digital models.  It concludes by suggesting that the flat-cut technique has a consequence upon both formal and textural properties of architecture that should be consciously embraced as a language that offers direct communication with readily available modes of digital fabrication.

**Conclusion**

While this text charts a transition from one project to another in terms of its technical improvements through parametric modeling it does so under the constraint of the developable surface and flat cut architectural detail. While this is partly motivated by production efficiency and extensive use of laser cutting techniques it also came, in part, from an interest in contextualism, typologies and symbolism along with the desire for an intentional sense of flatness. As the project developed so too did the consideration of flatness as a specific architectural device. In both cases this two-dimensional appearance is intended as a register upon which aspects of context and locality are played out. Both the cutting and bending process became important methods by which the familiarity of the typology and decoration were estranged via these flattening techniques.[19] In this way the laser cutter turned out to be particularly appropriate to these aims. The sense of compression of architecture towards an infinitely thin surface is part of its commentary and intentional aesthetic. In part this method is indebted to Venturi’s play on the overtly flat signification of cutout elements of his buildings.[20] While much of VSB’s work pre-empted use of CNC cutting in its detail and language it also provided important lessons on the economy of expression in architecture i.e. the flat, vertical surfaces of the building provides the most cost effective register for architectural communication. Today these expressive opportunities can be explored by architects more cheaply and quickly with advanced methods of fabrication. While digital fabrication supports a wide range of architectural outcomes it is interesting to note that in terms of the material that many of them begin in a state of flatness after which they are formed or bent into the appropriate shape. This period of flatness is implied both in the developable surface and in the double-curved surface of lateral and bi-directional sectioned structures. These two projects look for further applications for this understanding of flatness through a consideration of the developable surface and flat-cut ornamentation. They are considered in terms a particular aspect of digital fabrication from the design process through to completion. They suggest that a rigorous analysis of the alignment of digital fabrication with contemporary methods of production will help widen its use within the built environment. In this instance the sense of flat-cut architecture arises from the most effective and readily available means of digital fabrication.

## Notes

1 Iowa, USA
2 EAAE / ARCC 2008 conference text.
3 Term used by Venturi Scott-Brown to describe a particular relationship to context that is other than a passive or mimetic.
4 This relationship is set in constraints the prevalent association conjured by a set of accepted tropes of digital production. These can be briefly described as biomorphic, quasi Darwinian on the one hand or futuristic and high tech on the other.
5 Edward R. Tufte. Envisioning Information – Escaping Flatland p.14
6 Full team was comprised of Sioux City Chamber of Commerce, Downtown Partners, Siouxland Transit, State Steel, Missouri Valley Steel and Fimco.
7 “Sioux City – A Potential History” - Masters thesis Nathan Kalaher. p.48
8 Carried out with George Elmslie. It is not clear how much of this design is attributed to Sullivan and how much to Elmslie. See Louis Sullivan and George Grant Elmslie by David Gebhard. The Journal of the Society of Architectural Historians, Vol. 19, No. 2. (May, 1960), pp. 62-68.
9 Behrokh Khoshnevis is a professor of Industrial & Systems Engineering and Civil & Environmental Engineering, and is the Director of the Center for Rapid Automated Fabrication Technologies (CRAFT) and Director of Manufacturing Engineering Graduate Program at USC
10 I introduced students to work of Wim Delvoye and particularly agricultural associations of the tattooed pigs.
11 This project responds to the Sioux City context by mimicking those absent building typologies in quasi-historical scaled down forms and in their tattoo of abstractions of Prairie Style decoration of the American Midwest.
12 EAAE / ARCC 2008 conference text.
13 We found that function like the “Hole Wizard” to largely in effective an instead placed holes in original components and then “converted components” in assemblies. For more information on this see http://www.solidworks.com/pages/onlinetour/popup.cfm
14 in this case a company called K-Zell
15 Shop technician rates range from 20 – 30 dollars per hour while a similar in-house technician usually less than 20 dollars per hour.
16 For 20 gauge the laser ran at 2900 mm/minute at 3600 Watts while for the ¼” ran at the same feed rate but at 3600 Watts.
17 Illustrator allows conversion of spline curves to polylines of different resolution.
18 Architecture in the Digital Age: Design and Manufacturing by Branko Kolarevic.
19 See also Wim Delvoye Madison Square Park, Manhattan Doris C. Freedman Plaza, Manhattan June 2003 to October 2003
20 Particularly the house in Greenville, DE, (1980) or the House in Stony Creek, CT (1984).

Jonathan Foote

# L.B. Alberti's *ad unguem*: Longing for unhindered productions

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# L.B. Alberti's *ad unguem*: Longing for unhindered productions

**Unhindered Touch**
Francesco Colonna, Hypnertotomachia Poliphili, (1499)

Writing during a time of great change in the profession of architecture, Renaissance architect L.B. Alberti wrote in his treatise on architecture, The Art of Building in Ten Books:

*...avoid using the same color or shape too frequently, or too close together, or in a disorderly composition; gaps between pieces should also be avoided; everything should be composed and fitted exactly [ad unguem], so that all parts of the work appear equally perfect.*[1]

Alberti's Latin describing a perfectly fitting joint, *ad unguem*, translates literally as 'to the fingernail'. *Ad unguem* was a common phrase employed by Roman sculptors and stonemasons for judging correct fit, testing the work through the tip of the fingernail by gliding unhindered across a well-fitting joint.[2] Presumably, parts which fit together poorly, which have 'gaps', cannot be identified by the sculptor with the eyes alone. Rather, the fingernail must be employed as a means for probing the work for proper fit. In this way the sense of touch, extended from the outermost point of the body, is employed as the best and final instrument for refinement. Alberti, by invoking *ad unguem*, is not only speaking about the physical gaps between the parts of a building, he is also cautioning against intellectual 'gaps' as well – those places in the work which are manifest in "disorderly composition". The continuity between mind and material implied in ad unguem is indicative of Alberti's carefully constructed theory of architecture. In the prologue of the Ten Books, for example, Alberti explains that the “building is a form of a body [*corpus*]”, consisting of “lineaments and matter [*lineamenta et materia*]”, yet depends on the “hand of the skilled workman to fashion the material according to the lineaments”, as supplied by the mind of the architect.[3] Consistently within Alberti’s treatise, formal correctness has a reciprocal relationship with material correctness, as is emphasized in the recurring theme of the building as a body.[4] This is well stated early in the treatise in the book on lineaments:

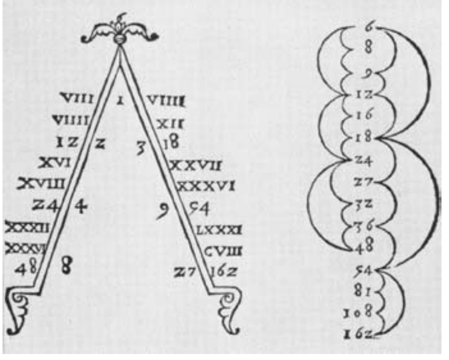
*...each member should therefore be in the correct zone and position; it should be no larger than utility requires, no smaller than dignity demands, nor should it be strange and unsuitable, but right and proper, so that none could be better.*[5]

Alberti refers to this refinement as concinnitas, describing it as the “absolute and fundamental rule in Nature”.[6] Buildings following this principle are a complete and consonant body, judged according to outline [*finitio*], number [*numerus*], and position [collacatio].[7] Reinforcing the interdependence of mind and material, Alberti introduces the intellectual concept of *concinnitas* in his book on materials. Here he states that the parts of a building, “imbued with refined variety [*concinnitas*]”, ought to marry practical convenience with the “demands of proportion and harmony”.[8]

Ad unguem, as a metaphor determined through concinnitas, is indebted more to classical poetry that to that of ancient marble-workers. Dating back to the earliest Latin poets, ad unguem was borrowed from the workshop as a metaphor for describing a perfectly proportioned and refined poem. The Augustan poet Horace famously invokes *ad unguem* in his censure of a badly proportioned poem, writing in his treatise on poetry, *Ars Poetica:*

*You, O*
*Sons of Pompilius, condemn that poem which*
*many a day and many an erasure has not pruned and*
*whittled down and chastened tenfold to the nail [ad unguem].*[9]

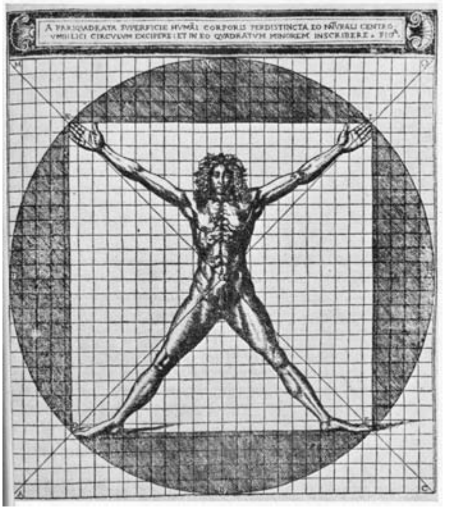
This fluid rhetorical adoption of a practical convention by Horace reflects an inherent transparency between the material and the poetic imagination. This is well summarized by philologist Armand J. D’Angour, in his commentary on Ars Poetica, “The oeuvre is thus imagined as something whittled down from a block of marble or a lump of clay, and the image is rounded off at its close by *ad unguem*.”[10] The digits, then, become the check for ‘fit-ness’, both speculatively and practically, seeking the most refined arrangement of parts within a harmonious whole. The fingernail, as was likely known by Alberti, was a periodic metaphor employed in classical texts on the making of art and poetry.[11] Alberti reintroduces *ad unguem* back into the physical realm of architecture, further solidifying its power as a crafty metaphor and his status as a scholar of classical texts. Recalling Horace’s *ad unguem*, for example, Plutarch quotes from an earlier Greek saying:

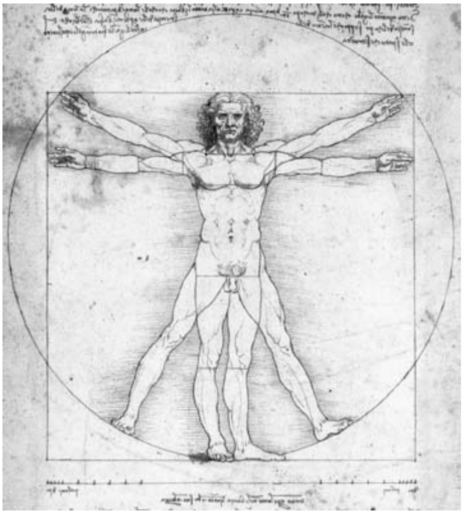



**Da harmonia mundi** Fra Giorgi (1525)

**The consonant body (finitorium)**
De statua, L.B. Alberti, Fresne (1651)

**Outstretched finger of the Vitruvian man**
Top, Cesariano (1521); below, Leonardo da Vinci (c.1487)





*The objects of art are initially quite formless and shapeless; then later each part of the figure is articulated in precise detail. This is what Polyclitus the sculptor meant in saying that the work is hardest when the clay is at the nail.*[12]

As both a formal and material instrument for refinement, these examples suggest that the fingernail is well equipped to inspire the material imagination. For Polyclitus the fingernail is simultaneously the symbol of both refinement and shear labor. Even though the passing of the unhindered nail-tip signifies the perfected *opus*, Polyclitus' clay-filled nails are reminiscent of the necessity of obsessive labor in achieving the well-pared work.

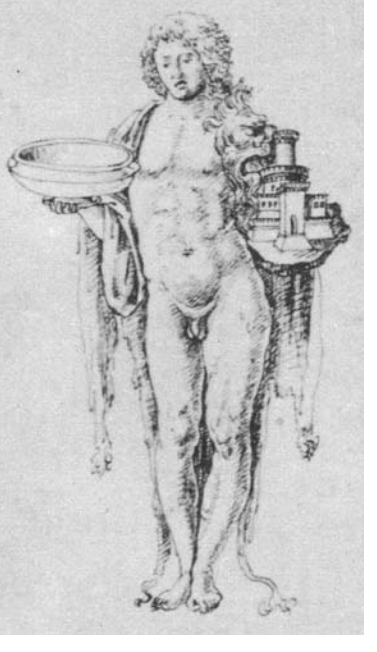
Situated most remotely from the center of the body, the fingertip naturally houses the miraculous point of touch; "the sense of the body in its entirety", as Lucretius writes.[13] Touch is often represented as the point of exchange for both the divine and the material imagination. Michelangelo most famously records this in the extended finger of Adam on the ceiling of the *Cappella Sistina*, revealing the *imago dei* as a metaphor for divine touch. In contrast, Albrecht Dürer, in his depiction of Saint Thomas, reminds us of the power of touch for verification in the material world, to reveal what our mind and eyes cannot see.[14] In perhaps the most interesting for architecture, Renaissance depictions of the Vitruvian man reinforce the extension of touch to mitigate between the ideal and the real. The privilege of tracing the outline of the ideal human proportion is often left to the out-stretched fingertip.

Alberti's invocation of *ad unguem* performs a dual purpose: on the one hand, *ad unguem* further strengthens Alberti's sense of the affinity between formal and material refinement; and, on the other, it serves to elevate his intellectual position as an architect through the borrowing of a known classical metaphor. This distancing from the medieval convention of architect as carpenter or mason is characteristic of Alberti's treatise, which sought to wrestle the architect from his traditional status in Hugo of St. Victor's *artes mechanicae*.[15] Although the nature and extent of this transformation is frequently debated, the profession of architecture was nevertheless undergoing enormous changes during the transition from the medieval to the Renaissance.[16] The architect was moving away from his roots in the craft guilds and embracing new responsibilities as an intellectual concerned with building.[17] Alberti sought to construct an intellectual structure which elevated the authority of the architect through both speculative and practical knowledge. To this end the architectural idea became increasingly solidified within off-site speculation as embodied in drawings and models, paving the way for the now largely accepted notion that architecture is produced prescriptively away from the building site.[18] The privilege of dictating the work of architecture through drawings and models came largely through the elevation of practice by knowledge of geometry. Through the making of a drawing produced away from the building site, an architect could now describe the building process with greater entirety. Still, even though the architect would relinquish a direct hand on construction, Alberti asks the architect to imagine the potentials and pitfalls of construction "...as though we were ourselves about to construct the building with our own hands [*manu aedificaturi*]"[19]. As Renaissance painter Lorenzo Lotto captures in his

**Medieval architect with set square and tracing compass**
Vie de Saint Offar (13th cent

**Ad unguem as embodied in the architect's drawing**
Portrait of an Architect, Lorenzo Lotto (c.1525)


**Portrait of L.B. Alberti: Anon.**
(c.1450), Biblioteca Nazionale, Rome



**Dinocrates presenting his model**
Francesco di Giorgio (1489), Biblioteca Nazionale, Florence

*Portrait of an Architect*, ad unguem now operates through the medium of the architect's drawing. Holding a drawing compass and gently touching a rolled drawing, Lotto's architect expresses the dual mode of the hand as both active and contemplative. The rolled drawing, now in transit between the drawing board and building site, becomes the symbol of reflective practice.[20] By the fingertip and compass, Lotto's architect prudently tests and measures his idea to refinement.

Central to this discussion and to *ad unguem* is the question of authorship. *Ad unguem* implies that the one testing by the fingernail is presumably the one who has the most direct control over its further refinement. Alberti, in invoking *ad unguem*, suggests that it is possible for the architect to become the maker of a building in a similar way as Horace is to a poem. In the *Ars Poetica* the material of the idea is the word, as constructed into verse. For Alberti the material of the idea is the drawing or model, as realized in a constructed building. Echoing Vitruvius, who stated that only the architect has "a definite idea of the beauty, convenience and propriety that will distinguish it",[21] Alberti suggests that that the task of refinement resides firmly within the chief author of the idea, and not in the hands of the mason or the carpenter. Now, through the making of a drawing, a single hand can direct many hands, further solidifying the emerging professional separation between the architect and the builder.[22] The authority of drawing was largely achieved through the elevation of architecture into a the realm of the *artes liberales*, conceived in the realm of mathematics through the study of geometry.[23] Now the architect could strengthen his status as an intellectual concerned with theory while at the same time leveraging such knowledge through its practical application on the building site.To this end Alberti writes, in the prologue of the *Ten Books,* "the carpenter's hands are but an instrument to the architect".[24] There can be little doubt that Alberti viewed this removal of the direct hand in construction as a solidification of authorship rather than a diminishing of it. Thus the authority of *ad unguem* is transmitted not only through the direct access of the extended fingernail, it also resides in the metaphorical extension of the idea into the material realm.

While drawings and models would become the predominant medium in the production architecture, Alberti was careful to warn against techniques of drawing and model-making which distract from an unmitigated examination of the relationships among the parts.

*...the presentation of models that have been colored and lewdly dressed with the allurement of painting is the mark of no architect intent on conveying the facts; rather it is that of a conceited one, striving to attract and seduce the eye of the beholder, and to divert his attention from a proper examination of the parts to be considered.*[25]

In other words, the idea does not reveal itself solely through visual, formal representations, but requires a careful examination of the facts of construction and proportion to reveal the true ingenuity of the architectural idea.[26] To judge the work *ad unguem* presumes a direct access to the material of the idea as expressed in a drawing or model, a privilege which brings new responsibilities. To know a building is also to know how it is realized, which is why Alberti sought a treatise composed, like the body of a building, of both *lineamenta and materia*. An architect working *ad unguem* cannot be seduced by visual effects but must demand a deeper, more probing examination in order to judge according to *concinnitas*. He must, as Polyclitus might advocate, get his fingernails dirty, since to work an idea *ad unguem* requires unrelenting, agonizing effort. For both the poet and the sculptor, the material of the idea cannot be expected to align perfectly after the first fitting; rather, it must be minutely whittled, measured, and tested until nothing can be added or removed but for the worse.[27] Material which is hard enough to be tested by the nail is presumably highly resistant to both the mind and the chisel. For Horace in the *Ars Poetica*, verses are as impenetrable as sculptor's marble, allowing them to be worked to the point where imperfections are undetectable by even the closest scrutiny.

The fact that, for Horace and Alberti, correct fit is measured 'digitally', or with the fingernail, makes this phrase a particularly potent metaphor for the examination of new digital technologies. Perhaps there is a clue in Alberti's call for refinement in the reciprocation between mind and material that can help us move beyond the simple pro/con debates which typically surround the role of a digitally inclined architect. In this way it seems the fingernail of the architect is well equipped to extend the well-pared idea into an equally refined sense of material and construction, regardless of technology. Like Alberti, who advocated drawing over a direct hand in construction, the digital architect must resolve new techniques within a changing relationship to the actual products of architecture.

Within this framework, several general attitudes seem to emerge, all of which reflect varying states of authorship with regard to the completed building. One trend is that digital fabrication allows the architect to remove him/herself further from the uncertainties of construction site, seeking to determine beforehand the building in its entirety through the integration of parametric modeling, BIM software, and the digital contractor/fabricator. The best possible scenario is that choices regarding construction, sequencing, and costs are updated in real time and are the result of known, predictable circumstances. Ideally, all decisions are made either before breaking ground or within a predictable set of parameters once construction begins. Often the BIM-driven architect must resist the pressures of technical specialization within a complex project management structure, hedging the power to see the entirety of construction as the architect's central contribution realization of a building project. In this way the chief product of the architect becomes information, as represented in a BIM model, containing all technical aspects of a building project in a single database. This central model exists as the common language between all invested parties, allowing the array of other specialists, from insurance assessors to steel fabricators, to pull relevant information. The BIM architect rests his or her confidence in a well crafted information model that will predictably allow the various pieces of construction to arrive on time, well coordinated, and within budget. Because of its potential to coordinate complex endeavors, the architectural information model is generally highly favored within large, bureaucratically oriented projects often requiring hundreds of team members within a structured management team. Many large government and commercial clients now require BIM because of its promise to minimize costly overruns. Design standards are therefore increased through better project coordination.

L'arte di costruire

L'Architettura

**Personification of  builder and architect**

Relief sculpture on the  Campanile del Duomo, Florence, Workshop of Andrea Pisano (c.1336)

**Filarete and His Dancing Disciples**

Bronze doors of St. Peter's, Antonio Averlino known as Filarete, Rome, 1445

**Ad unguem reaching between idea and material**

Iacomo Barozzi da Vignola, frontispiece, Regola delli cinque ordini d'architettura, Rome, 1562

**Genius constrained by poverty**

*Emblemata*, Andrea Alciato, Padua (1621)

The total integration of design and production has also been hailed as the re-emergence of the architect as master builder. The digital master builder is the modern form of the popular notion of the medieval architect-as-master mason, who led construction through both the direct hand of the chisel and the pointing finger of instruction.[28] Certain architects embracing a BIM-integrated practice are seeking to exploit the inherent technical bias in database modeling as an opportunity for total control within an innovative and reflective practice.[29] The product now becomes the architectural idea, coming from a single entity, firm or individual, as expressed in a digital model of a future building. The architect's idea is perceived as passing from a digital representation into real material, unmitigated by technique, material, and constructive realities. The master builder paradigm seeks to regain total control over the relationship between idea and construction, envisioning a direct hand in construction through the mitigation of advanced technology. The new goal is, in quoting a prominent digital fabricator "to take whatever is in the mind of the architect and make it real."[30]

From this position we see the emergence of the concept of 'digital craft', in perhaps the most expressive potential of Alberti's *ad unguem*. Digital craft proposes to translate the spirit of the craftsman across technological barriers, endeavoring to merge the formal freedom provided by digital technologies with the material intimacy of traditional craft culture. In attempting to bridge this divide, however, we have to ask ourselves what really is implied in the idea of 'digital craft'. In one sense, there is no longer any craft in the actual fabrication of digitally generated products, since agency is no longer dependent on the handed intervention of a craftsman. However, as a metaphorical reading, 'digital craft' has the potential to work within the same notion of refinement as embodied in *ad unguem*. Just as the sculptor worked the material to the exactness of the nail, the new digital architect, working through advanced tools, can demand the same refinement. The pivot point in the refinement of an idea *ad unguem* is technique: the sculptor's privilege of judging correct fit lies partially in the fact that he posses the knowledge of how to achieve it. Filarete, a sculptor himself, depicts this well in the self-portrait on his bronze doors for St. Peter's. At the head of a line of dancing workshop disciples, Filarete triumphantly points toward the sky with the traced point of a large compass. Through the difficult practical work of the *bottega*, the architect can have access to the material of the divine imagination.[31] A result of one of the most technical and difficult casting processes, Filarete's doors demonstrate that *ad unguem* not only signifies a refined sense of worked material, it also signifies the harmonious idea, whittled down laboriously by the nail to its most exact proportions.

*Ad unguem*, as a measure of refinement, looses some of its potency when taken in light of the emerging class of purely speculative digital architects, of which there are many current examples.[32] At this point mostly an academic undertaking, these architects exploit the power of computing technologies to expand formal possibilities through the manipulation of mathematical models rather than visual or material ones. Technique is raised to its highest status, with the architect seeking to work directly inside the technical language of the computer software as a method for invention. In this sense the product of the architect becomes the computer script, concealing authorship behind the invisible hand of the computer.[33] In opposition to the 'master builder', the speculative architect tends to demote constructive and material realities, seeking instead to elevate the productions of architecture as ethical and aesthetic statements over material ones.

In fact, much of the current debate surrounding the employment of digital fabrication techniques parallels quite closely Alberti's 15th century concern for the transparent touch between well-fitted parts and a well-fitted idea. The modern digital architect, through a revolution in technique, once again faces sweeping changes in his or her relationship with the building site, bringing into the forefront the critical relationships between constructing and construing. Often with a hemisphere's distance between the architect's office and the building site, the material of the architectural imagination tends to reduce itself to that which is easily transmissible, often confined largely to its formal and visual aspects. Perhaps Alberti envisioned a similar conflict upon the removal of his architect from the building site, which is why he reserved a large portion of his treatise for practical matters. For him, the authority of the removed architect originated from knowledge in both mind and material.

The power of digital fabrication technologies to expand formal possibilities is well documented and easily observed. The material resistance which once empowered the Roman sculptor to test *ad unguem* has been largely overcome through technology. Since the barrier between constructing and construing is so seemingly transparent with digital fabrication, the main reward in production becomes tends to favor the visual. With this, the ease of material manipulations has raised the formal imagination to an almost universal hegemony, often leaving material and constructive realities at the service of formal desires. The seamless operations empowered with digital tools have the potential to create false illusions of refinement, since what was once extraordinarily difficult or impossible can now seem quite effortless. Digital craft, taken in the spirit of *ad unguem*, holds the potential to leverage the power of digital machines to see both the entirety of construction and its every particular.

As a recurring theme in Renaissance iconography, Genius is often constrained by the poverty of expression. Without the resistance of the world, unencumbered talent would have direct access to the divine imagination. Typically, the man of *ingenium* is portrayed with an outstretched hand, reaching for the divine idea through extended fingertip, only to be inhibited by the weight of earthly being, as represented by a brute stone tied to his wrist. While the impression of divine perfection seems within reach to the enlightened mind, the earthly bounds of material and construction must have their say. *Ad unguem* suggests that, instead of the unhindered mind, we ought to strive for a freely grazing fingernail. As a metaphor for refinement within the in-between world of mind and material, digital and traditional, the need for judging ad unguem has never been more important.

dedicado a c*

## NOTES

1 Alberti, Leon Battista, On the Art of Building in Ten Books (*De Re Aedificatoria*), translated from the Latin by Joseph Rykwert, Neil Leach, Robert Tavernor, MIT Press: Cambridge, Massachusetts, 1988, pg. 179. See n93, pg. 389, for translation of *ad unguem*. Subsequent quotations from the Ten Books are from this edition, unless noted otherwise.

2 D'Angour, Armand J. *Ad Unguem*, American Journal of Philology, Vol. 120, No.3. (Autumn 1999), pg. 411.

3 Alberti, pg. 5. Generally referring to the formal properties of the building, *lineamenta* are "conceived in the mind, made up of lines and angles, and perfected in the learned intellect and imagination" (pg. 7). They have "nothing to do with material", as Alberti resolutely states, yet are nevertheless invoked in the visual imagination and thus have extension and consistency. In empowering the making of drawings and models, *lineamenta* are therefore well equipped to reach across the space of mind and material. In a testament to this ambiguity, *lineamente* is notoriously difficult to translate and has generated considerable disagreement among scholars as to Alberti's intended meaning. For a recent survey of the history surrounding the interpretation of lineamente, see Branko Mitrovic, Serene Greed of the Eye, Deutscher Kunstverlag, 2005, pg. 39-47; and S. Lang "De lineamentis: L.B. Alberti's Use of a Technical Term," Journal of the Warburg and Courtauld Institute, 1965.

4 The body is a recurring analogy throughout the *Ten Books*, solidifying the notion that a building should be ordered according to Nature, refined in composition and material. Alberti writes, for example, "In short, with every type of vault, we should imitate Nature throughout, that is, bind together the bones and interweave flesh with nerves running along every possible section..." pg. 86; cf. also Alberti, pg. 23-24.

5 Alberti, pg. 23

6 Alberti, pg. 303

7 Alberti, pg. 302-303. See also, Jacob Burckhardt, The Architecture of Renaissance Italy. Secker and Warburg: London, 1984, pg. 30.

8 Alberti, pg. 35.

9 Horace, *Ars Poetica*, 291-94, as quoted in D'Angour, pg. 411.

10 D'Angour, pg. 415.

11 See D'Angour's analysis of *ad unguem*, who demonstrates that, although Horace's use of the metaphor is the most famous, there is a rich tradition in the metaphor of the fingernail as the measure of refinement in both Latin and Greek poetry.

12 Plutarch, *Quaest*. Conv. 2.3.2 636B, as quoted and translated by D'Angour, p. 420.

13 Lucretius, *De rerum natura*, II, 434, as quoted by Jean-Luc Nancy, The Muses, 1994.

14 For a recent interpretation of the phenomenological power of touch in architecture as embodied in Caravaggio's portrayal of doubting Thomas, see Juhani Pallasmaa, The Eyes of the Skin: Architecture and the Senses, Chicester, Wiley-Academy: Hobokan, NJ, 2005. Saint Thomas is also the patron saint of builders and architects.

15 See, for example in the prologue of Alberti's *Ten Books*, "[the architect] should no doubt be accorded praise and respect, and be counted among those most deserving of mankind's honor and recognition" (pg. 5). In addition, the architect must perform above the mere *operarium faber*, workman, who can "make something that appears to be convenient for use", and instead seek that which "will be perfect and complete in its every part" (pg. 315).

16 For an analysis of the medieval architect, see N. Pevsner, "The Term 'Architect' in the Middle Ages", Speculum, Vol. 17, No. 4, (Oct. 1942), pg. 549-562. Pevsner argues that the Vitruvian definition of the architect possessing both *ratiocinatio and fabrica* was preserved across the middle ages much more in southern Europe than in the north, and that the northern use of the term 'architect' made very little distinction between those involved in speculative planning and those engaged in practical work. In addition, it seems clear that north of the Alps the gradual professional separation of the architect from the operative master-mason occurred several hundred years later than it did in the south. For a summary of the myths surrounding the role of the medieval architect, see Andrew Saint, The Image of the Architect, Yale University Press: New Haven and London, 1983, pg. 19-50.

17 Wilkinson, Catherine, "The New Professionalism in the Renaissance", The Architect, Spiro Kostof, ed., Oxford University Press: New York, 1977, pg. 124-125.

18 cf. Alberti, p.315, “Questions such as these should be projected and debated by the use of models...”; cf. pg. 317 for an autobiographical description of the importance of drawing; and cf. pg. 318, in a plea to the architect to, ...”save your sound advice or fine drawings [*lineamenta*] for someone who really wants them.”

19 Alberti, pg. 58.

20 Both Alberti and Filarete advocated the use of carefully scaled drawings to prescribe future construction. See Alberti pg. 7, “let lineaments be the precise and correct outline [prescriptio]...”; and Filarete’s concept of construction drawings [*disegno proporzionato, disegno rilevato*], as opposed to those employed as a “*congetto*” or “*disegno in digrosso*”, see the introduction to Filarete, *Trattato di Architettura*, testo a cura di Anna Maria Finoli, Milano, 1972, pg. 61-64

21 Vitruvius, Book VI, 8.10, trans. by Morris Hickey Morgan, New York: Dover, 1960, p. 192. The relationship between Alberti and Vitruvius is a complex one, well summarized in Richard Krautheimer, “Alberti and Vitruvius”, Studies in Western Art, vol. 2, 1963

22 Evelyn, John, *Public Employment and an Active Life prefer’d to Solitude, and all its Appandages, Such as Fame, Command*, Riches, Coversation (London, 1667).

23 Emmons, Paul, “Architecture Before Art: Imagining Architectural Authority in Early Modern England,” ARQ, Vol. 10, no. 3/4, 2005, pg. 278.

24 Alberti, *De re aedificatoria*, 2.26 “fabri enim manus architecto pro instrumento est.” This translation is my own.

25 Alberti, pg. 34.

26 Alberti particularly advised against the use of perspective in the study of architectural constructions: “The architect rejects shading and gets projection from the ground plan. The disposition and image of the facade and side elevations he shows on different sheets with fixed lines and true angles as one who does not intend to have his plans seen as they appear, but in specific and consistent measurements”, pg. 34.

27 cf. Cicero, *De Natura Deorum*, I.xxxiii.92.

28 This myth has been largely dismissed in modern scholarship as both reductive and over-simplified. See Saint, chapter 2.

29 There are many examples of architects successfully pursuing aspects of the total integration of technology and practice: KieranTimerlake, SHoP, Diller Scofidio + Renfro

30 Personal conversation with J-P. Mueller, owner of OEC engineering, Chantilly, Virginia, USA, April 2006.

31 King, Catherine. “Filarete’s Portrait Signature on the Bronze Doors of St. Peter’s and the Dance of Bathykles and His Assistants”, Journal of the Warburg and Courthauld Institutes, Vol. 53, 1990, pg. 296-299.

32 See, for example, Marc Fornes at www.theveryman.net; Skylar Tibbits at www.sjet.us

33 See, for example, Mark Goulthorpe and his theory of precise indeterminacy, esp. Amanda Reeser & Ashely Schafer, “Precise Indeterminacy” Three Projects by Decoi and an Interview with

34 Mark Goulthorpe, Praxis 6, 2004. Much of current research in computer driven design seeks to mimic certain natural generative processes which defy prediction yet adhere to a knowable set of principles.

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# Guerilla Tactics of Parametric Design

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# Guerilla Tactics of Parametric Design

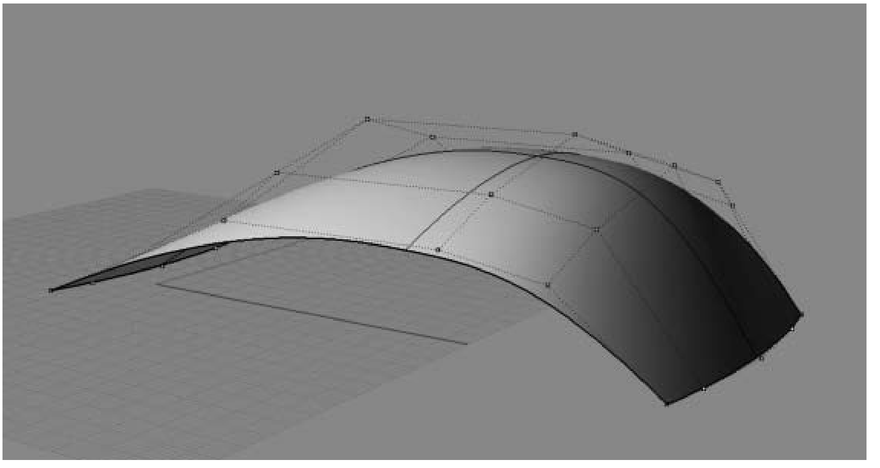
guerrilla |ge□rilel (also guerilla) – noun

a member of a small independent group taking part in irregular fighting, typically against larger regular forces : this small town fell to the guerrillas | [as adj. ] guerrilla warfare. ORIGIN early 19th cent. (introduced during the Peninsular War (1808–14): from Spanish, diminutive of guerra 'war.'

Our assumptions about the world of technology and design are leading us astray. We are being pulled unequivocally towards notions of efficiency (time and cost) and towards the idea that we are buying ourselves back into the business of design development. In reality we are not repossessing anything, but are simply passing our cost and time savings on to our consultants, contractors and clients. Parametric design, BIM (Building Information Modeling) and digital fabrication methods are rendering us, as architects, further obsolete and creating a world in which we are even more likely to create another big box store or a second lot of condos, with only the requisite shift in material or articulation.

We need only reference the introduction of Computer-Aided Design in the early 1980's, which promised a time of change in the field of design, to see that the speed and precision of technology is truly seductive. CAD technology was billed as device for making firms more efficient, thus reducing the amount of time spent on each project and netting the firm larger profits. This initial venture into CAD left some of the professions elder statesmen clamoring against these advancements. This resistance argued that digital software reduced design development in favor of a higher level of productivity and efficiency; as we all know the efficiency provided by CAD software has overwhelmingly won out and has now evolved into BIM. BIM software has enabled "smart models" to be utilized from early in the design process, streamlining the transition between design, documents, and construction. These smart models allow for precise material definition and custom detailing to be represented in three dimensions while producing automated versions of "traditional" construction documents, all from one three-dimensional architectural model. This time the profession, both young and old has wholeheartedly accepted the transition to information modeling under the auspices of an even more efficient model of practice. Though the reality of offering copy and paste building components once again reveals our inability to dissect the material or programmatic shifts necessary for creating a heterogeneous urban environment.

Another offshoot of the software development which was empowered by IBM's FORTRAN language, along with other CAD software, in the late 1970's, was geared towards the more lucrative aerospace and naval engineering fields, including, CATIA, Pro/Engineer and CADAM.[1]



NURBS Surface defined by Bezier curves

CATIA, originally developed by Lockheed and then sold and repackaged for a larger audience by Dassault Systems, was created as a platform for aeronautic design. CATIA by definition was designed to create monocoque design forms with diaphragm structural constraints provided by two rigid skins, one interior and one exterior. It was also capable of modeling highly complex forms driven by the aerodynamics of the object. These complex forms were made utilizing geometry formulated with Non-Uniform Rational B-Splines (NURBS) based surfaces. Developed in the 1950's by French engineer Pierre Bezier spline curves were developed to accurately describe the complex curvature becoming commonplace in the automotive industry. NURBS curves are a generalized branch of Bezier curves that infer relationships between points to describe a curvilinear line or surface, these curves do not lie on the associated control points but interpolate a series of surrounding points to describe the geometry.

These geometric descriptors have been utilized regularly in different software platforms since the late 1980's as geometric and computational software(s) began to articulate more complex curvilinear surfaces. NURBS based geometry allows the software to describe these shapes in an efficient and precise manner. This type of articulation has been incredibly important in the advancement of computer-aided design, as it empowered a new aesthetic into the design lexicon.

Not only did CATIA fully capitalize upon the geometric capabilities of NURBS curves, but it also allowed for parametric connections to be made between those geometries and other constraints, both geometric and algebraic. The integration of parametric software into the design and construction process allows for multiple shapes or designs to be pursued quickly and simultaneously once a defined set of parameters connected to a geometrical set have been defined. These parameters enable the software to reject a possible design whenever any criteria are not matched. The power of parametric design software is paramount when dealing with the interdependent systems and advanced compositional characteristics of alternative geometries now being utilized by architects and engineers.

Through parametric definitions the software's capabilities mimic the controls of other three-dimensional software, except it incorporates associative geometry through a set of constraints. These constraints allow for articulated structural geometries to be parametrically linked to the control surface(s). These parameters allow the entire model (structure and skin) to be controlled by definable objects or curves, including regulating geometry, a Boolean variable or a mathematical equation. This method provides for a high level of geometric control that can easily be modified even very late in the process. As well this software allows customized details to become a variant of a base detail, essentially utilizing the software to allow a set of mass customized details to permeate the system.[2]

These customized details could be anything, they are defined only by their geometric form. As with most every three-dimensional modeler, CATIA comes preloaded with its own set of default connection methods. As CATIA was initially formulated for use in the aerospace and nautical engineering industries, it is naturally equipped with joinery more typically associated with these fields. These tend to be joints for connecting steel and aluminum in typical methods, however they are deployed in very unconventional ways. While bolted and welded connections are relatively ubiquitous in architectural design, this type of convoluted joinery is very suggestive of specific construction techniques outside of the architecture industry.

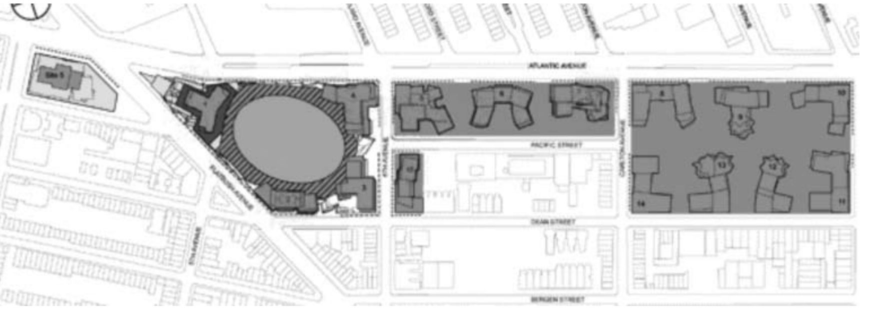
This awkward construction aesthetic is particularly apparent in the work of Frank Gehry's office. During the early 1990's, Gehry began to utilize CATIA to further pursue his ever more sophisticated curvilinear designs. He began utilizing the parametric capabilities of CATIA while pursuing the iconic Guggenheim Museum in Bilbao, Spain and fully explored the its potential in the long delayed, Walt Disney Concert Hall in Los Angeles. This software enabled Gehry's team to pursue the buildings overall geometry, structure and detailing simultaneously. Capitalizing on the power of the software, Gehry was able to calculate the number of three-dimensional panels on the façade, their curvature and directly supply the fabricators with the geometric information and detail to digitally manufacture the components.

The design aesthetic of Frank Gehry utilizes a series of predefined expressive surfaces (created with analog models) to create articulate curvilinear structures that are tightly skinned and essentially seamless. He is able to achieve this articulation through the exploitation of the fluid modeling allowed by NURBS surfaces. The ability to so softly maneuver surfaces within the software is seductive and empowers the designer to model with a level of detail beyond that of any other modeling method. The results of Gehry's design parameterization, however are derived from a superficial aestheticism that is then engineered into a set of overly articulated panels and structural steel sections. As mentioned CATIA was initially created to geometrically describe the fuselage of an airplane and this too becomes the aesthetic of Gehry's structures; a complex structure covered with a light metal skin of three dimensionally articulated panels. Let there be no misconception Gehry's buildings are a product of a form based non-digital design process, digitized and translated through CATIA into an expensive and barely constructible set of CNC (Computer-Numerically-Controlled) manufactured components.

Frank Gehry's relationship with CATIA has allowed him to parlay his success into the creation of an offshoot company of his booming architectural practice. Gehry Technologies is purely a software development company, releasing Digital Project in 2001, with the strong support of Dassault Systems. This new build or "silo" of CATIA, has renamed many of the aeronautic tools with definitions and an interface, which are more familiar to the architectural profession. With this venture Gehry has opened the rest of the field to the power of parametric design and enabled architects to parameterize their designs and details. Gehry's intentions with the propagation of this software is not necessarily to continue the investigation of it's capabilities, but instead to generate more complex form-making, and provide an avenue for his firm to sweep in with manufacturing and structural solutions to the proposals created with the software. While this system has functioned well in articulating the geometries desired by Frank Gehry, it is a system that is very specialized and increasingly expensive ($14,500.00/seat)[3]. Gehry's growth into the software and information systems market has further grown his already familiar brand.

The nature of the Gehry's buildings, products of his oft repeated process, have created a cultural phenomenon. This phenomenon has grown beyond that of any typical "star architect." This is most certainly a product of his architectural "brand", which expresses the elite and eccentric nature of most of his clients, and is a product of his ability to transcend familiarity within the industry to become a household name, appearing as a character on "The Simpsons" and taking on protégés the likes of Brad Pitt.

His designs are coveted to growing cities due to the perception that they are capable of changing cultural landscapes and/or regional economies in a fell swoop. Most exemplified in Bilbao, Spain, where his Guggenheim Museum is reported to be responsible for nearly 35% increase in the number of tourists to the Basque region from 1994-1999.[4] This change comes at a price, which few can afford, The Stata Center at MIT came to $442 per square foot, and over $650 when you include design costs, while the average cost per square foot of a typical science facility is $260 per square foot.[5] Though this perception does not come without its faults, to assume that a city can be composed of series of iconic landmarks with no structure for organized growth and public space is also problematic.[6] Additionally, the use of architecture to create a spectrum can easily be read as an attempt to create a wolf in sheep's in clothing. When a developer knows that the scale or composition of a project will provoke resistance from a community it has become a more normalized part of the process for the architectural design to be used to cloak this criticism.



Plan of "Atlantic Yards" as proposed in 2003

Take Atlantic Yards, a development project over the Vanderbilt rail yard located between downtown Brooklyn, NY and Prospect Park. Bruce Ratner, CEO of Forest City Ratner, bought controlling interest of the New Jersey Nets (National Basketball Association Franchise) with plans of moving them to a new arena located as the hub of this 22-acre development. Formal plans for the project were announced on December 10, 2003, and reported on the next day in the New York Times as a $2.5 billion development plan with 17 towers designed by Gehry, including a projected 2.1 million square feet of commercial space and 4,500 residential units.[7] Almost immediately civic and neighborhood groups began to rally together in protest of the project.

Ratner's purpose in choosing Gehry as the project architect is quite transparent, in a conversation with New York Magazine's Kurt Anderson he stated that spending the 15 percent extra per square foot to hire Gehry, was a purely political ploy.

*"Ratner isn't spending 15 percent extra on these new buildings simply because he wants to underwrite cool design. He understands that in Brooklyn, just as his quotas of apartments for poor people and construction jobs for women and minorities were ways of winning over key constituencies, hiring Gehry was politics by other means, sure to please the city's BAM (Brooklyn Art Museum) loving chattering class. "The spirit of what you say," Ratner agrees when I posit this theory, "is accurate."*[8] (Kurt Anderson)

Further groups have gone so far as to define the project as a cloak masking the project to the larger population.

*Jonathan Cohn states, "…the project is also a Trojan Horse. The promise of a major project in New York City by Frank Gehry has been enormously successful in muting potential opposition by the cultural "elite". But the project only looks like a gift because it's wrapped by Frank Gehry; the architecture masks a slew of problems."* [9]

Though this is nothing new, Brooklynites and New Yorkers as a whole have a long history of vehemently resisting the most massive of development projects in the city.

The resistance has been broad, developed and well- organized, working in both very public and also, befitting of Brooklyn, very subversive ways. Develop, Don't Destroy Brooklyn[10] (DDDB), is one group of over 800 interested volunteers that has formed to organize the public resistance. DDDB has organized a set of principles that define their objection to the project and layout alternative methods for development.[11] DDDB in conjunction with the Council of Brooklyn Neighborhoods has developed an alternative design for the site called the Unity Plan.[12] The Unity Plan purports a more human scale of develop and density, through a diversity of urban design methods focused on accessible public spaces. A second group of investors, Extell Development Company, has also developed an alternative plan, which uses as its primary principle to "disavow taking property through eminent domain."[13] A documentary film focused on the proposed design, "Brooklyn Matters"[14] has been released by Building History Productions (Directed by Isabell Hill). There have been a myriad of rallies setup throughout the city to voice public opinion regarding the project. These protests continue to be organized now in the spring of 2008.

All of this begins to describe the failure of Gehry's design to cloak anything, in particular a 17 tower development, in a frosting of acceptance and disinterest. In fact it could be said that Gehry's involvement has fanned the flames of public interest. Gehry himself has in fact become the focus of much of the reactionary protest. Beyond the typical op-ed articles in the local paper, and even beyond the candlelight vigils, which were organized in protest of the Bilbao Guggenheim.[15] Tee shirts emblazoned with "Fuck Frank Gehry" started sprouting up around Brooklyn (a creation of Barnaby Harris) which Gehry, in stride noted…

"I thought it must have been the people in Brooklyn who are sort of angry. But then I thought, well, it must be loving, too. So I decided it was funny, and I put it on. And I wore it to the office, and everybody got a kick out of that, and then I wore it to the gym."[16]

Murals painted within Prospect Heights tie Gehry's work to the use of eminent domain to purchase pieces of the puzzle, which were missing from Ratner's scheme.

"I'm a do-gooder, I see architecture as a service."[17]

By Gehry's own admission he is uncomfortable with the situation that is created by his involvement, the scale, and the methods of action, with the Atlantic Yards project. "I'm very insecure about it," Gehry said of the Brooklyn project. "I've brought all kinds of people in to beat me up, because I want to get it right."[18]

Gehry has said he had repeatedly prompted Ratner to scale back the project. Having failed at that task, he asked that others might be involved in hopes of breaking the project into more


Mural in Prospect Heights
Atlantic Yards Report

digestible pieces. Speaking at a live broadcast at Columbia University, "He [Ratner] wanted to be able to deal with one person, so he refused,"[19] Gehry said. Later he reflected, "Sometimes I think I should be less polite," -- implying that life would be easier if his buildings weren't all attention-getters. Later he called Atlantic Yards "out of scale with the existing area," and said that the project has been such a struggle that it makes him want to "jump off the Brooklyn Bridge."[20] During the question and answer session Norman Odor (Journalist who reports via his blog The Atlantic Yards Report) observed a woman wearing a " t-shirt and a sticker saying "Eminent Domain Abuse," asked, "Have any of your previous projects involved the use of eminent domain or eminent domain abuse? Does that square with your principles? And would that be enough to make you walk away from the Ratner project?" "No comment," Gehry responded.

It is reported that the new Governor of New York (as of February 2008), Gov. David A. Paterson, called for a statewide moratorium in 2005 on the use of eminent domain. On March 21, 2008, it was reported that the project has been put on indefinite hold due to a lack of financing.[21]

Gehry's work generates an air of interest, a buzz, though as a product of his notoriety, he has found that that attention is more detrimental to his work than beneficial. We would argue that this is a product of his product. His desire to create larger and larger constructions with the same methodology stands in contrast with the forms themselves. Their relationship to humans, and to the limitations of his software. At the scale of a tower Gehry's designs are constrained to a small layer of icing on an otherwise nominal planametric layout. The product the software is developed to create is one which wants to be concealed in BOTH an exterior and an interior skin. There is no honesty to the form, no expression of material quality or character, no exposed engineering, and no ethical responsibility to the community.

We propose to reconceive the way in which we use the capabilities of this software. Having considered the process of design utilized by the Skunk Works[22] in the 1970's to design the F-117A stealth fighter, and previously the SR-71 spy plane. Skunk Works in the development of the crystalline form of the F-117a fighter first calculated how to create the minimal radar signature of their aircraft, a parameter that had to be absolutely perfect. By defining one specific parameter they were ensured of a successful design per at least one definition. Once this primary task is successfully developed, they worked to solve all of the other limitations articulated by the primary parameter, the geometry. This required a fly by wire system, an on board computer which constantly monitors the aircrafts, speed and orientation and makes instantaneous minute adjustments to keep it steady. We propose using Gehry's software with the same method of prioritization. We must begin by defining the formal limitations of the material or construction method we intend to use.

The use of CATIA, or other parametric design software, could just as simply use a bow/banana truss or a space frame as construction methods, if only the form were linked back to the definition of these components. We propose that in fact this is a far more ethical and constrained method for deploying the software. We begin by defining and analyzing a system that we would like to explore. One of the first methods we attempted to use was conventional standing seam metal roofing, manufactured throughout the world and deployed in a myriad of environments and programs. We envision a tessellated use of the standing seam, maintaining the typical interlocked connection along seams and through a bracket back to a structural system. The system we proposed will cut the seam along each edge at particular intervals defined by the system. This geometrically defined and constrained system limits the form, by connecting the moves which are made along one edge of a surface by pulling or pushing on the opposing edge, to increase the area of the shape near the altered edge. Though the form doesn't accommodate specific forms that a designer may envision, it gives the designer a form driven by its materiality, in a smarter method similar to that of algorithmically defined form-making, so popular in academic circles. This method can make for a much more culturally coherent and connected design method, one which expresses efficiency and takes advantage of digital fabrication methods not as a method for making elitist icons, but for making inexpensive poignant designs. Gehry's own public image could use a change of this sort, it has changed dramatically over the last five years as he has struggled with his choice to remain cornered with an elite list of clientele.

The tools embedded in the parametric technology such as CATIA create a system for the use of large sheet metal goods to be cut down inefficiently and applied to skeletons of disjointed and grotesque usages of steel and structure. These same tools can be reverse engineered to create systems using inexpensive and conventional cuts of materials to create objects that are identifiable and unique while remaining within the constraints of typical construction processes. In contrast, by creating methods for deploying conventional materials and methods in unconventional we ways we can educate the profession to create buildings of craft and precision, icon and expression, for clients that can really use them for the betterment of their business or cause. Though parametric software has become synonymous with excess and flippant design, the software also comes with the ability to utilize materials in unconventional and affordable ways. Technology, perhaps for the first time, is capable of understanding a material's constraints; we must choose how to employ these tools or risk that our profession will become further removed from the definition of our environment.

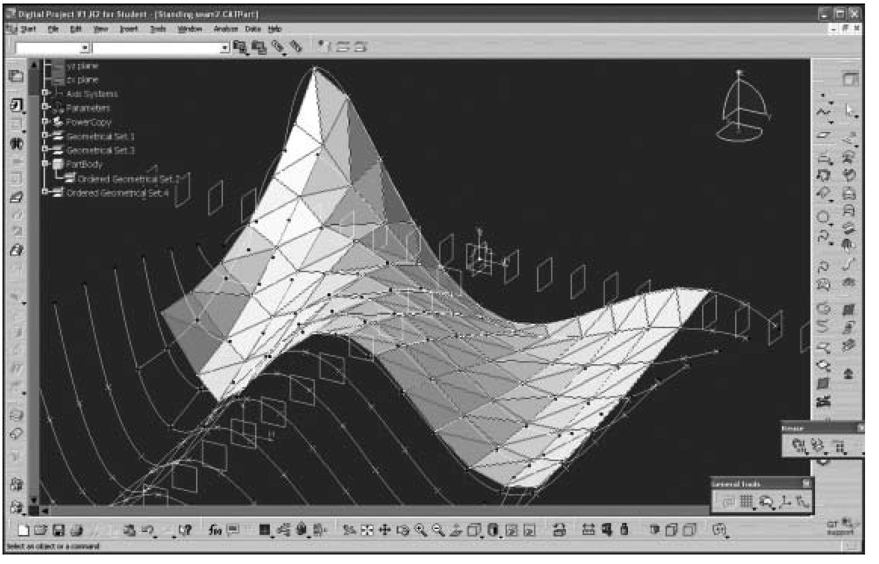



**Figure 1**

Gehry Technologies Digital Project (CATIA) model of Standing seam metal roofing bent (broken) to form an unconventional skin

## Notes

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2 This method is called power-copying, where one detail complete with its relationships to a control surface(s) are instantiated throughout other joints with similar control surface(s) or curve(s).

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5 Jessie Scanlon. "Frank Gehry For the Rest of Us." Wired Magazine. Issue 12.11, November 2004.

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20 Kelvin Sealey. Interview of Frank Gehry, "Citizen: The Campus Talk Show" October 31, 2005.
21 Nicolai Ouroussoff. "What will be left of Gehry's Vision for Brooklyn." New York Times, March 21, 2008.
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#B1

# #B2

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# Measurable and Non Measurable in Architecture

## 3 case studies of the Non Linear Solutions Unit

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# Measurable and Non Measurable in Architecture

## 3 case studies of the Non Linear Solutions Unit

**Abstract**

In the last fifteen years architecture's frequent use of complex digital design instruments, such as algorithms, dynamic relationships, parametric systems, mapping, morphogenesis, cellular automata and bifurcation with broken symmetry, clearly shows how contemporary thinking in mathematics and physical sciences has changed the way we think about design. The incorporation of dynamics, n*onlinear s*ystems, chaos theory, emergent properties, resilience, etc., has altered our perception of the life of today's cities.

The pilot model, Applied Responsive Devices (ARD), is a methodological approach formulated to question how the change of paradigm affects the decision-making of designers. ARD has been developed within the context of the Nonlinear Solutions Unit (NSU) at Columbia University's Architecture School. The purpose of NSU is to analyse the impact of the change of paradigm in architectural research and to consolidate research in the field of complex systems in architecture. It questions how to enhance the organisation and transfer of architectural knowledge by activating a strong interaction between analogue and digital modelling. ARD's role is to embed sets of constraints within the modelling process that affect the decision-making of the designer. The innovation includes the way in which quantitative and qualitative parameters (i.e. social, physical, sensorial, cultural and economic) are aggregated in order to emphasise the concept of formal adaptation.

Some architectural problems can be managed with a classifier system consisting of a set of rules, each of which performs particular actions every time its conditions are satisfied by a specific informational attribute. By taking into account the experimentations developed in the field of cognitive sciences (Holland, 1992), the methods contained in this proposal investigate the existing relationships between the perception of a specific reality and its translation into a set of elements that can be manipulated through computerised models.

### 1. Architectural codes and the definition of the threshold between the *Measurable* and the *Non-Measurable*

The idea of architectural codes operates on a double level.

The first, acting within the field of the *Non-Measurable* or metaphysical, aims to improve our understanding of the universe. The second, by operating in the context of the *Measurable*, has the purpose of improving the technical level and accuracy of the architectural tools; it focuses on application to concrete cases as regards achievement, production and project management.

In a first phase architects' interest is focused mainly on the *non-measurable* dimension of the code. They query the relationship existing between architecture and its possible translation into symbolic language: the relation existing between architecture and pure mathematics. The chance to express and understand a specific reality through the formulation of mathematical expressions representing its internal organisation questions the essence of the relation existing between a specific reality and the reading we do of it.

During the nineties, architects' use of the code was mostly based on its direct transposition to the architecture of tools developed in other scientific fields. The use of instruments deriving from computer science such as cellular automata, or from botany such as L-system and other rewriting techniques, algorithms borrowed from genetics or systems devices such as the complex adaptive systems developed within the field of cognitive sciences, provided architects with new instruments supporting formal and conceptual investigation. The transition from the classical paradigm to the science of complexity, engendered a new vision of architectural research. It engendered an epistemological change in architectural approach.

In effect, in a complex-structured city in which the interactions among parts intensify, in which the number of decision-makers and cultural scenarios overlap, interconnect, and sometimes collide, in which the temporal dimensions of the citizens are dissimilar, in which local and global, physical and virtual dimensions co-exist, it is necessary to respond with new typologies, new complex urban organisms and new research tools. Architects have to face different realities, in which building typologies and space-using modalities are continuously coming under question. It becomes crucial to define a set of complex adaptive tools which are able suitably to manage these complexities within the system.[1]

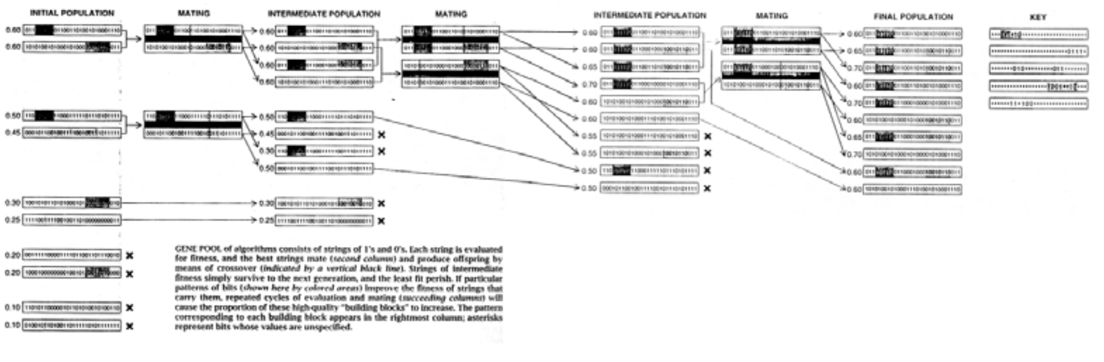



**Figure 1**

Example of genetic algorithm

Information available from: url:http://www.econ.iastate.edu/tesfatsi/holland.GAIntro.htm

The introduction of advanced digital tools deriving from the science of complexity promised to be a strong support to the architectural research. The adoption of tools developed in other scientific fields allowed architects to have a new vision of traditional architectural problems. The use of algorithms and codes derived from complexity science allowed architects to discover forms of order and hidden organisations that couldn't be revealed by traditional tools. For example, the adoption of abstract apparatus, such as the Universal Turing Machine,[2] that is capable of growing indefinitely, allowed architects to manipulate formally the concept of the infinite. By applying a generative algorithm for a number almost unlimited of iterations, it was possible to radicalise the formal experience previously explored in the eighteenth century by Ledoux, researching the infinite via the endless repetition of a geometric system.
Nevertheless the use of techniques deriving from science of complexity slowed down dramatically in the mid-1990s.

This state of affairs is because of two conditions:
Firstly, the direct transposition of tools deriving from other scientific fields presented many limitations. On a practical level, there was difficulty in controlling instruments whose mechanisms were not familiar to their users. In effect, since those tools were developed in the science of complexity, it was impossible to understand or manipulate their internal rules. Secondly, it was impossible to create a direct connection between the formulation of a problem, the enunciation of the expected performance of the tools used to solve it, its expression in a codified digital algorithm and finally the refinement of the tool itself.
In architecture for more than a decade the use of codified systems was mostly a digital utopia rather than a real practice.
Today, architects' interest focuses mostly on the Measurable dimension of the code. The goal is to develop architectural instruments capable of creating a direct relationship between the mathematical expression of a specific performance (formal, visual, static, acoustic, sensorial, etc...) and their constructive formalisation.
Where the field of the *Measurable* and the field of the *Non-Measurable* are concerned, architectural codes consist of creating new functions. To make an architectural code means to define a set of relations between the parts of a system.

**2. The code as the creation of new functions**

A code is the articulation in symbolic language of a conceptual model.
Some architectural problems can be managed with a classifier system, consisting of a set of rules, each of which performs particular actions every time its conditions are satisfied by a specific informational attribute.
To codify means to express part or totality of a project with an algorithm: firstly to articulate a problem by defining different levels of complexity starting from the most elementary units and the enunciation of their attributes; secondly to identify the properties and relations connecting the different elementary units; thirdly to translate them into rules or algorithms (starting from the simplest *nonlinear* expression as in the case of if/then rules); fourthly to organise them into a

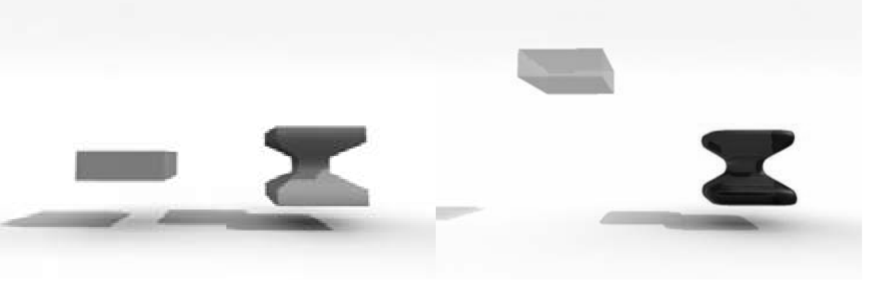


**Figure 2**
Example of parametric relation connecting two polygons
The change of the colour of the right polygon affects the Z position of the left polygon. Image by courtesy of Nonlinear Solutions Unit, GSAPP, Columbia University.

hierarchical system expressing the way in which the rules are organised and perform (as is the case with tools such as cellular automata and genetic algorithms); finally to specify the conditions under which the rules will evolve over time (complex adaptive systems etc…).
In practice, building a code means making an idea by inventing a function.
This operation corresponds to the development of a real language.
In science, as in architecture, making a code is a creative act.

### 3. Applied Responsive devices at NSU

It is on the basis of the previous considerations that the research on Applied Responsive Devices was carried out by the Nonlinear Solutions Unit at the Graduate School of Architecture, Planning and Preservation at Columbia University. The Nonlinear Solutions Unit, NSU, is an advanced research centre, whose purpose is to investigate the relationship between the methodologies and procedures developed in sciences of complexity and the solution of complex architectural problems. .
NSU operates on two levels: within the theory field by collaborating with various academic institutions; and within the practical field, by working on specific case studies developed in collaboration with architectural and engineering firms.
Applied Responsive Devices operate as an educational and professional decision aid tool giving assistance to the decision-maker in fixing the priorities related to a formal, functional, technological or engineering problem.
ARD also:

- Supports architectural reasoning through time-based simulations.
- Develops and refines the research tools through computational methodologies.
- Defines a strategy to allow the easy tracking of errors.
- Provides a conceptual and instrumental platform and a service to the scientific, architectural and engineering community.
- Contributes to the science of learning by providing an innovative methodology.

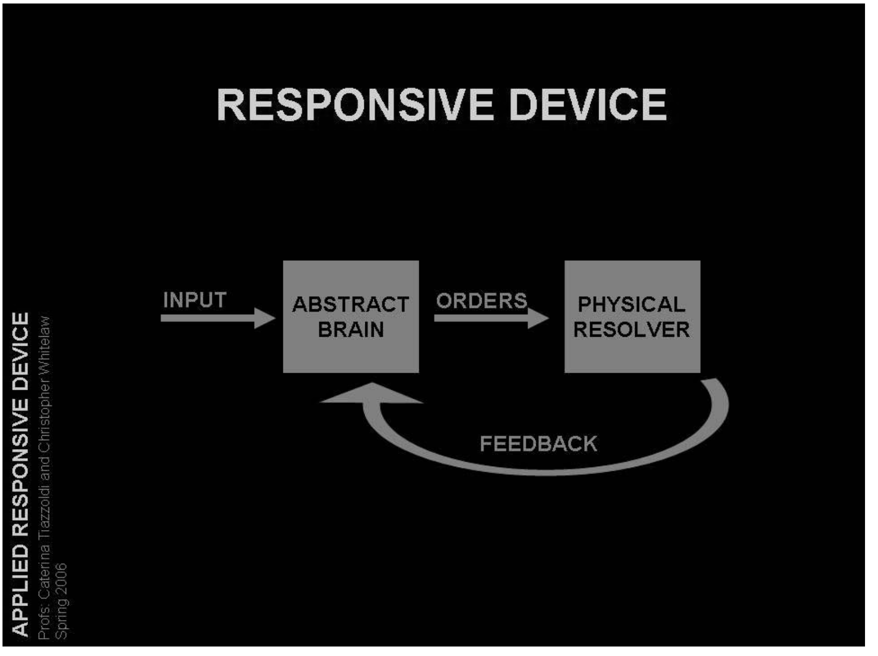



**Figure 3**
Applied Responsive Devices
Applied responsive devices create a direct relationship between the formulation of an idea, its translation in numerical input, the articulation of the set of rules or abstract brain connecting the input with the formal response of the physical resolver. Image by courtesy of Nonlinear Solutions Unit, GSAPP, Columbia University.

ARD‘s objective is to develop a direct connection between the expression of a specific expectation (functional, formal and aesthetic) and its achievement through the development of a code-based model.
ARD innovation includes the way in which quantitative and qualitative parameters (i.e. social, physical, sensorial, cultural and economic) are aggregated in order to emphasise the concept of formal adaptation.
From a methodological point of view the ARD process takes advantage of research done in other scientific fields (as in the case of research carried out by John Holland in the field of cognitive sciences).
In ARD methodology the first step consists of enunciating the expectancies and analysing the environment conditions, in translating them in elementary units and attributes that can be manipulated as the input of the digital model.
ARD’s second step consists of defining the rules connecting the primary units and the hierarchical system organising them is the ARD *Abstract Brain.* The third phase identifies those architectural components which can provide an appropriate correlation between the input and the rules of the problem. Those elements are the Physical Revolver.

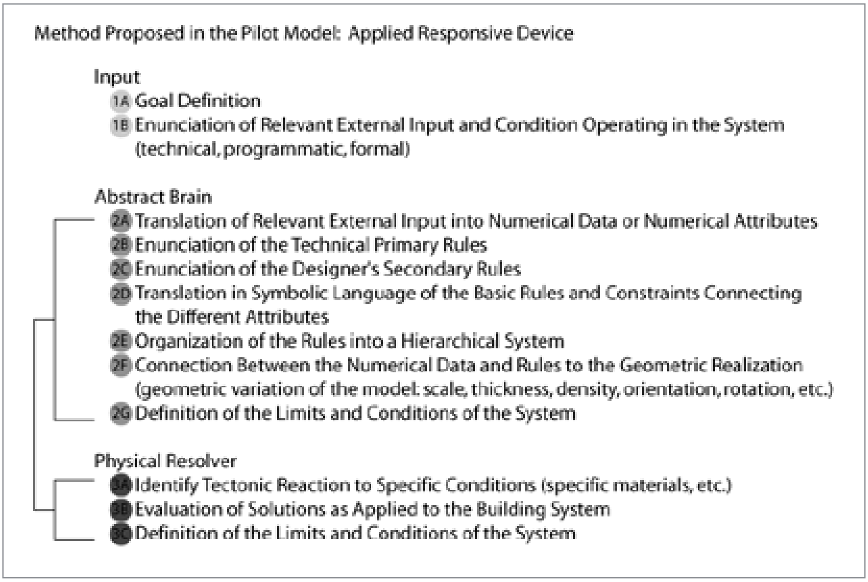



**Figure 4**

The various sequences of the pilot model Applied Responsive Devices

Image by courtesy of Nonlinear Solutions Unit, GSAPP, Columbia University.

In the last stage, a process of feedback will check and calibrate the system of rules of the Abstract Brain with the Physical Resolver tectonic solutions.

In this way, Input, Abstract Brain and Physical Resolver are closely entangled.

The interest of ARD lies in integrating, directly into a three-dimensional model, the constraints and the design formulations of the architect.

On a practical level, the possibility of connecting the apparatus of a project with an algorithm - for example, a system connecting the various components of a façade, the primary and secondary elements of a structure - allows architects to manage an increasing level of complexity in the design process. Indeed through the enunciation of a limited number of rules, it is possible to control the production of thousands of parts in a number almost unlimited of variations.

It is important to remember that, although the potential of new instruments seems endless, in the scientific and architectural world it is not feasible to work with models in which the number of interconnected variables is too high. In the scientific context, the case of Colouring Problems (below) demonstrates that it is almost impossible to work with devices that have more than four variables.

In the architectural projects, where the number of variables is obviously higher than four (social, functional, technological, formal, visual, historical and economic), it is not realistic to try to translate an entire project into a codified system.

**Figure 5**

CASE STUDY 1 ARD1

Copertura, a finite-element model derived from a parameterised agent-based model organising sets of Kalzip tiles. A collaboration between NSU and Maire Engineering for the project New University of Turin by Sir Norman Foster and with Ken Tracy & Jeffrey Taras. Image by courtesy of the Nonlinear Solutions Unit, GSAPP, Columbia University.

The goal was to optimise the constructive process of a double curvature for the roof of the New University of Torino by using standard metal panels. The problem has been solved by applying the ARD technique. Firstly analogical data (such as the physical properties and the engineering limits of the material) were translated into numeric attributes. The length, width, flexional and torsion capacities were expressed as numeric input. Similarly, the final formal configuration of the roof was translated into numeric input. The translation in numerical data of final position x, y, z became the target of the replicating device operating in the system. In a second phase, NSU researchers developed a simple artificial intelligence embedded in the computer-simulated panels. They defined the rules qualifying the behaviour of the system: duplicate panels until the achievement of optimal configuration (established on the basis of an approximation to the final form defined by the designers). If the addition of a new panel would engender an excesses compared with the prefigured final size, the system would start with a new combinatorial sequence of panels until it found the optimal configuration. The process worked in a feedback loop operating a constant integration from analogical to digital data and vice versa. Image is by courtesy of the Nonlinear Solutions Unit, GSAPP.

In its *Measurable* dimension, the code can be used to analyse part of a problem: it can be used to model part of a given reality.[3]

One of the goals of the ARD research is to overcome the limitation of only four variables by using a combinatorial process as a tool of innovation. The project *Applied Responsive Device 4: Parametric Bookshelf* uses a combinatorial system to achieve an endless number of configurations of a bookshelf by applying a system of combinatorial local rules to the four attributes

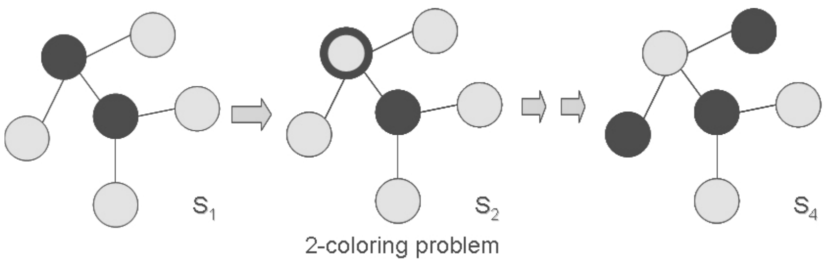



**Figure 6**
Colouring problems
An example of combinatorial optimisation of a 2-parameter system. The rule: none of the elements could be connected with an element of the same colour.

qualifying the system (scale, thickness, colour saturation and depth). Parametric Bookshelf is a bookshelf that has been designed with the objective of obtaining three types of performance: adaptability of the size to different customers' requirements, capacity to unfold endless configurations and finally to develop a system that is economically sustainable. The algorithm of Parametric Bookshelf operates on a double scale. On the global level it develops intelligence similar to that of the project ARD1 Copertura. It specifies the modality of growth of the system. On a local level a network of interdependent rules connects the four attributes qualifying Parametric Bookshelf and permits us to obtain an unlimited number of configurations.
The goal of ARD, similarly to John Holland's concerns about the model, is to identify the correct variables that are able to affect the development of a project meaningfully.
*The project Applied Responsive Devices 3: Formal Modulation for Light Performance in a Women's Hospital Façade* can also be considered as an example in which the application of a limited number of variables permits the development of solutions producing a combinatorial innovation. Each solution of ARD3 focused on the qualitative, and quantitative, understanding of algorithmic responsive devices as applied to the constructed reality of a women's hospital façade system. The goal of this research was to develop a project responding simultaneously to interior programmatic shifts, the perceptive requirements and external site information. This task was achieved by implementing an algorithm to connect the pattern of the window façade framing to the functional, sensorial and technical requirements of the building programme.
In the case of ARD3 the idea of design performance did not refer not only to a criterion of technological optimisation, but above all to the client's request to obtain an inedited formal result. Consequently NSU researchers developed a system of rules connecting the modulation of the direct light with the different programmatic uses of the space (rooms, surgery rooms, waiting areas, entrance hall).
Two strategies were developed for connecting formal solutions to technological performances. The first one connected the rotation of a series of metal bars with the amount of light desired in the various spaces. In a repeat performance this solution was re-interpreted in the project for

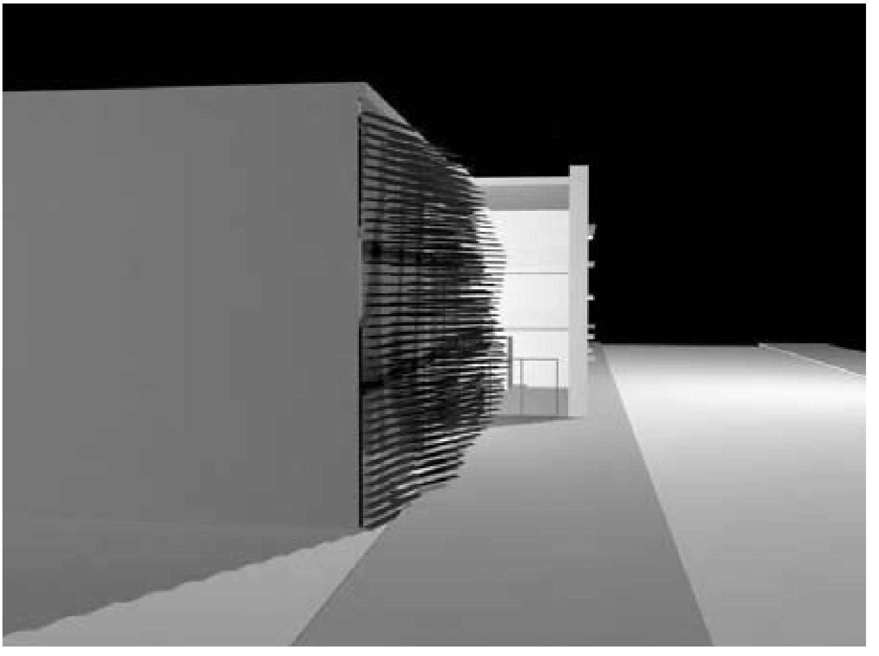


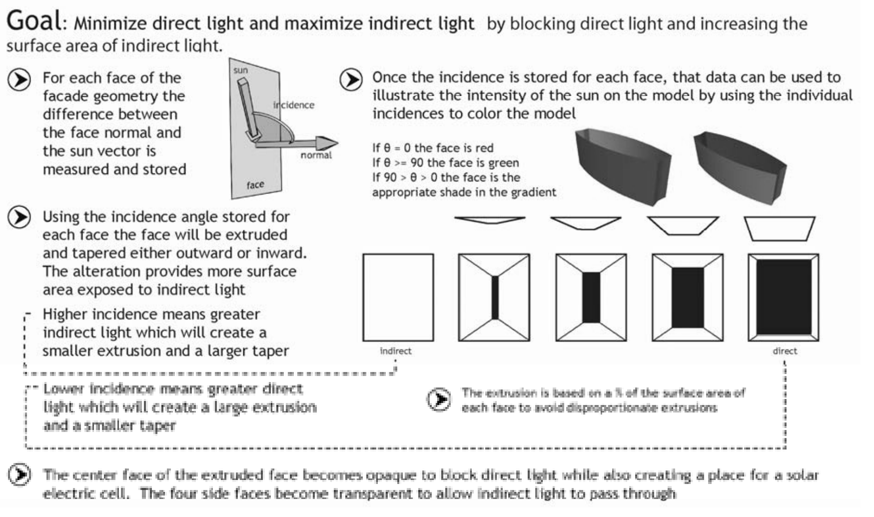
**Figure 7**
Applied Responsive Device 5
Formal Modulation for Light Performance in the building of the Enete Parchi of Vaude city, in collaboration between, NSU, Arch. Ilaria Cafasso and the architecture firm Nuova Ordentra, the rotation of the façade element depends to the modulation of the direct light in the building. NSU - GSAPP Columbia University, Fall 2007, Image on courtesy

**Figure 8**
Applied Responsive Device 3
Formal Modulation for Light Performance in Women's Hospital. Rotation of façade frames based on programmatic input, NSU - GSAPP Columbia University, Principal Investigator, with L. Yang, Client Impresa Rosso, Spring 2007. Image by courtesy of Nonlinear Solutions Unit, GSAPP, Columbia University

the building of the Ente Parchi of Vaude City – the result of collaboration between NSU, the architectural firm Nuova Ordentra and the architect Ilaria Cafasso.

The second project proposal developed in the context of the research ARD 3 *Formal Modulation for Light Performance in a Women's Hospital Façade* consisted of a number of diamond-shaped window elements. Each component had a solar panel placed in the front. The size and placement of the front panels were related to the modulation of the direct light penetrating the different programmatic spaces and responding to the curvilinear shape of the building. The algorithm was developed to fit any type of surface.

Examples ARD 3, 4 and 5 demonstrate that the use of a combinatorial logic, achieved with a proper selection of the attributes and parameters acting in the project, permits us to overcome



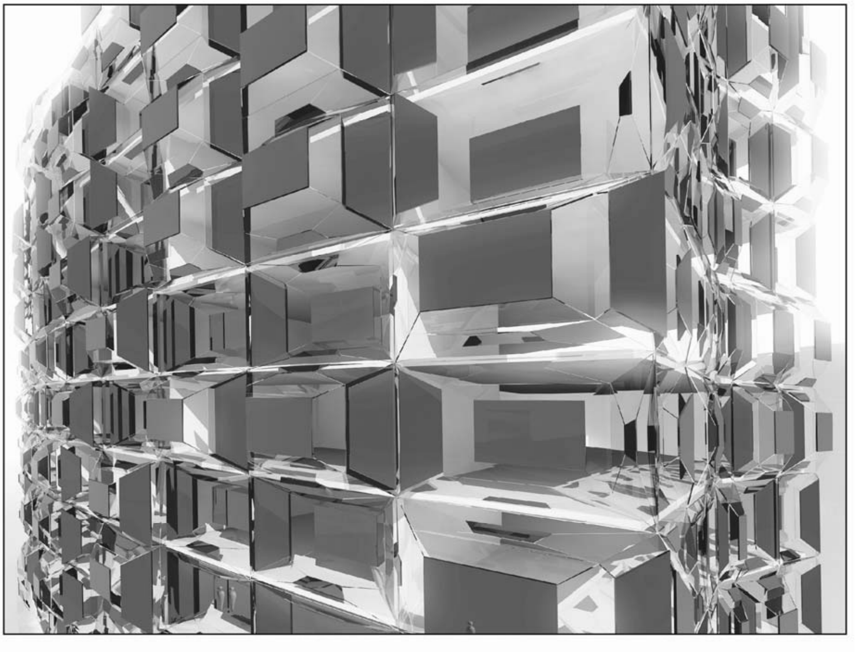



**Figure 9**

Applied Responsive Device 3

Formal Modulation for Light Performance in a Women's Hospital. Extrusion of façade frames based on the programmatic input of the building and the modulation of the direct light. The algorithm developed can fit any type of surface. NSU - GSAPP Columbia University, Principal Investigator, with Will Craig, Client Impresa Rosso, Spring 2007. Image by courtesy of Nonlinear Solutions Unit, GSAPP, Columbia University.

limitations on the use of a limited number of variables. The code allows us to treat many different situations. One of the potentialities of the ARD research is the capacity to embed the designer's intentions in the design process.

### 4 The codification and the definition of the new thresholds of the *Measurable* in architecture

A code is the network of rules representing the relations that connect the different components of a project. To codify means to translate a conceptual model, in a sequence of 1 and 0 that can be recognised, and therefore processed, by a computer. It signifies translation of any object or concept in a series of numerical attributes that can be manipulated as digital data.
This operation is easier when working with concepts belonging already to the field of the *Measurable* and having therefore a correspondent in numerical data (for example, the concepts of distance, weight, light intensity, weight, sound level, colour saturation, transparency, thickness). The numerical expression of entities that do not have a numerical correspondent in the first instance seems to be more a theoretical assumption than a reality.

To overcome the apparent distinction existing between *Measurable* and N*on-Measurable* elements, it is necessary to engage with the question of the boundary existing between hard sciences (mathematics, physics) and soft sciences (biology, sociology) and between the idea of objectivity and subjectivity.
According to Ilya Prigogine, the transition from classical sciences to sciences of complexity engendered the redefinition of the threshold between hard and soft sciences. In effect, Boltzmann and Poincaré's theories linked any type of observation to the subjectivity of an external observer: such a condition questioned the existence of absolute and objective verities. Consequentially they questioned the distinction between quantitative and qualitative, between objective and subjective. The transition between classical sciences to sciences of complexity blurred the boundary between the *Measurable* and the *Non-Measurable*.

John Holland, referring to the idea of creative reductionism, mentions the possibility of defining a new boundary for the *Measurable*. It is possible to redefine constantly the *Measurable* limits by connecting *Non-Measurable* entities with *Measurable* ones. According to Holland,[4] in cognitive science, 'any human can, with the greatest of ease, parse an unfamiliar scene into familiar objects – trees, buildings, automobiles, other humans, specific animals, and so on.'[5] This decomposition allows the translation into *Measurable* entities of elements that initially were *Non-Measurable*. Such an operation is a conceptual associative act that cannot be realised by a machine.[6] To reduce or to decompose a *Non-Measurable* entity in a set of numeric data is a creative act unfolding new fields of the *Measurable*.

Holland's idea of creative reductionism reflects some aspects of the Gilles Deleuze idea of concept-making. By connecting and putting in related ensembles of concepts it is possible to define new concepts.

Similarly in architecture the question is how is it possible to achieve the transformation of *Non-Measurable* in *Measurable* concepts that could be manipulated through a computer model? How is it possible, and is it legitimate, to manipulate numerically elements that usually belong to the field of the qualitative? For example, how could we translate the concept of privacy in a set of numerical registers? Is it possible to assume that we can reduce it to a set of spatial conditions (for example, the presence of visual and acoustic obstacles)?[7]
In such a context John Holland's idea of creative reductionism is finalised to reduce a situation to a set of attributes and building blocks that can be digitally manipulated. It implies the creation of a database or a classifier system that is able to grow endlessly.
It is therefore possible to create new definitions and to make *Measurable* what was not.

To connect, to express according with and association of pre-existent building blocks reminds us of Deleuze's idea of the manufacture of new concepts.
The translation of architectural ideas in code can be seen as an ultimate creative act challenging the boundary between the *Measurable* and the *Non-Measurable*.

**Notes**

1 Bertuglia C., Rabino G., Tadei R., La valutazione in campo urbano in un contesto caratterizzato dall'impiego di modelli matematici, (Torino: Celid, 1991);Bertuglia C., La città come sistema complesso: significato ed effetti sulla strumentazione metodologica e sulla prassi, nonchè sui presupposti concettuali che sono alla base della strumentazione metodologica e della prassi, (Torino: Celid, 1994);

2 Chu K., "Metaphysics of Genetic Architecture and Computation", Perspecta: The Yale Architectural Journal, no. 35, 2004, pp. 74-97;

3 Nevertheless the application of the code in the *Measurable* dimension of architecture most of the time is limited to bi-dimensional surface of a trimensionalised surface embedding a limited number of variables. In such a way it is possible to control the tools operating on the project. This is why in the last few years the architectural scene has been characterised by the use of codes limiting themselves to pattern-making on the top of a surface.

4 John H. Holland is a professor of Psychology and a professor of Computer Science and Engineering at the University of Michigan; he is also an external professor and member of the Board of Trustees at the Santa Fe Institute, a MacArthur Fellow and a Fellow of the World Economic Forum. His two most recent books are *Emergence: From Chaos to Order and Hidden Order: How Adaptation Builds Complexity.*

5 *From Chaos to Order* by John Holland available from: http://www.cscs.umich.edu/ ~ crshalizi / reviews / holland-onemergence /.

6 'This quick decomposition of complex visual scenes into familiar building blocks is something that we cannot yet mimic with computers', *Chaos to Order* by John Holland is available from: http://www.cscs.umich.edu/ ~ cr-shalizi / reviews / holland-onemergence /.

7 Legitimating such operations depends on the fact that any architectural concept, in order to become built architecture, needs to become quantitative information. Any design concept or sensorial performance to become architecture has, by the means of drawings and texts, to become a set of numeric inputs that can be transmitted to the executor. Any architectural idea is destined to become numeric expression. The principle of the code in architecture is to understand how much it is possible to anticipate this operation by transcription of an architectural project in a codified expression.

Caterina Tiazzoldi

# Applied Responsive Devices

## A methodological proposal to enhance the interaction between analogical and digital approaches in architecture

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# Applied Responsive Devices

## A methodological proposal to enhance the interaction between analogical and digital approaches in architecture

**Abstract**

"In a complex-structured city in which the interactions among parts intensify; in which the number of decision-makers and cultural scenarios overlap, interconnect and sometimes collide; in which the temporal dimensions of the citizens are dissimilar; in which local and global, physical and virtual dimensions co-exist, it is necessary to identify a set of design tools which could respond to design complexity. That is why in the last fifteen years architects have adopted advanced digital tools such as algorithms, dynamic relationships, parametric systems, mapping, morphogenesis, cellular automata and bifurcation with broken symmetry.

In the first phase architects' interest focused on the direct transposition into the architecture of digital tools deriving from other scientific fields. The use of such tools led architects to discover forms that were inconceivable with traditional procedures. Nevertheless, in the mid-1990s the lack of control of tools that were not specific to architecture engendered a drastic reduction in the initial enthusiasm for such an approach"[2].

The research Applied Responsive Devices (ARD), developed by the Nonlinear Solutions Unit at Columbia University Architecture School, focuses not on the tools but on the methodologies developed in other scientific fields. ARD examines how it is possible to set up a model that operates a correct interaction between the analogical and digital environment. It analyses the possible applications of a model (to demonstrate, to analyse and to discover) and the properties that it should embed (resemblance, repeatability and robustness) to be efficient.

The methods contained in this proposal investigate the existing relationships between the perception of a specific architectural condition and its translation into a set of elements that can be manipulated through computer models. It probes how a given problem can be translated into a codified symbolic language.

In fact, some architectural problems can be managed with a code, consisting of a set of rules, each of which performs particular actions every time its conditions are satisfied by a specific informational attribute. ARD's interest is to embed sets of constraints within the modelling process that affect the decision-making of the designer. This project aims to develop an innovative tool that assists a decision-maker to take into account a number of different parameters. The goal is to enhance architecture's capacity to respond to specific environmental requirements with an adaptable physicality. From an epistemological perspective ARD's research operates as a heuristic device aiming to challenge the boundary existing between the Measurable and Non-measurable dimensions in architecture.

**1. The change of paradigm: from analogical model to digital code**

In science, codes are the translation into digital symbolic language of a conceptual apparatus or of an analogous model. It is legitimate to raise the question of which conceptual apparatus in architecture precedes the code.

To answer this question an NSU researcher analysed the applications and properties of the scientific model. This operation was driven by the wish identify models' architectural correspondents. The advanced research lab Nonlinear Solution Unit at the graduate school of NSU aims to understand not the techniques but the methodologies deriving from other scientific fields. The motivating factor at NSU is the will to consolidate the research field of complex systems in architecture. The goal of NSU is to promote and support research and educational projects related to complex dynamics in architecture by taking advantage of the creative and scientific potential of the projects developed within the GSAPP.

In the search for the definition of the abstract apparatus that precedes the architectural code it is possible to assume the architectural diagram as the code predecessor, as the analogous apparatus preceding the digital tool. To justify this assumption it is necessary to analyse some of the properties characterising the use of the model (as the predecessor of the code in the scientific field) and of the diagram.

If we compare the American architect Peter Eisenman's idea of the diagram and the model concept of the scientist John Holland[3], the similitude between the two tools appears clearly. For Eisenman, as for Holland, diagrams and models have three types of applications: to analyse, to demonstrate and to discover. According to Eisenman and Holland, to evaluate qualitatively and quantitatively a diagram and a model, it is necessary to estimate three properties: Resemblance, Reproducibility and Robustness.

Diagrams and models are often used as a conceptual apparatus supporting architectural and scientific reasoning. When used as analytical tools diagrams and scientific models are particularly useful in the early stages of research. They can also be useful to look for an adequate model to support a work. As the scientist Cosma Shalizi[4] affirms, in their initial stages, some researches involve a component of chance and creativity.

One begins research by applying different interpretative models on a data set, and secondly, by modulating the parameters of the adopted model. This procedure permits us to find some emergences or patterns in a set of data. The identification of those configurations permits us to find a form of order in a system that originally appeared as chaotic.

In addition, the use of the model as an analytical tool is also very important in more advanced stages of research. As regards architecture, according to Peter Eisenman, the diagram is historically understood in two ways: as explanatory and analytical and as a generative device.[5]

The ability to process a huge amount of data with a computer allows researchers to analyse quickly the implication of different theoretical scenarios in a given situation. In other word it is possible to see which interpretative model fits better in a given case study.

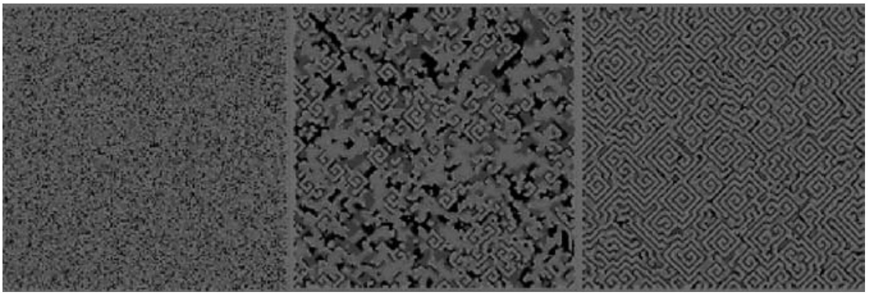

**Figure 1**
Different visualisations of the modulation of the parameter time on a model used to analyse some data. The modulation of one parameter on the same model allows visualisation of forms of order or patterns in a set that was initially chaotic.

In a second phase this capacity to analyse a vast amount of data quickly permits us to modulate the weight of the different parameters acting on a particular model.

'Demonstrate' is the second function that scientific models and architectural diagrams have in common. In effect a scientific model can be used to validate or to falsify a hypothesis.[6]
Nevertheless it is important to note that in architecture the use of a model as a demonstrative tool should be very limited. In effect the probative capacity of a model depends on its repeatability. The repeatability is the capacity to reproduce the same experiment in very similar conditions to allow comparison between the various results. In architecture the heterogeneity of the different case studies -deriving from the huge variations in the different situations- makes it almost impossible to apply an identical model to a similar case study.
'Discover' is the third function characterising scientific models and architectural diagrams. This is perhaps the most interesting from an architectural perspective. Given that a model is the representation of a reality through a system of rules, such rules have the capacity to produce results autonomously. They are therefore endowed with certain independence from their users. They can reveal aspects that their designer never intended. For this reason, according to John Holland, 'A model, like a hypothesis, suggests where to look'.[7]

In the same way for Peter Eisenman the diagram is a tool allowing the designer to enter situations where it has never been before.[8]

With regard to the criteria permitting evaluation on a qualitative and qualitative level of the potentialities of a scientific model, it is possible to identify three properties: resemblance, reproducibility and robustness.

A close reading will show that the same properties can be used to evaluate the qualities of an architectural diagram.
As regards resemblance it is necessary to distinguish between two different interpretations of a model resemblance: the first, closer to the idea of formal similarity, focuses on the reproduction of a given reality on a different scale. In this first case the level of resemblance depends exclusively on a visual factor.
The second interpretation of the idea of resemblance refers to the development of a system that is capable of representing the abstract relations and the intrinsic qualities qualifying an object.
The first static interpretation is opposed by a dynamic notion of the idea of resemblance. This second understanding aims to describe the overall behaviour of a system in perpetual transformation or, as is the case in complexity sciences, in a condition far from the equilibrium.
In its second interpretation, the idea of a scientific model shows a strong similarity with the concept diagram explored by Gilles Deleuze.[9] According to the French philosopher, a diagram is a representation or a map of the relationships and of the intense forces operating in a system.
In architecture, it is possible to find a similar interpretation in Peter Eisenman's formulations. For the American architect, the diagram is a tool to mediate between a palpable object and the laws that govern its intrinsic behaviour.[10]
On the subject of the resemblance, models and diagrams share another similarity. According to the idea of the two mathematicians Livi and Rondoni, and the scientist John Holland, the level of resemblance of a model depends on its ability to make a system understandable by offering a simplified reading and representation of a given situation.
Regarding the relation existing between the idea of resemblance in the scientific models and diagrams Peter Eisenman affirms that the diagram 'is a representation of something in that it is not the thing itself'.[11]
John Holland says that to select a correct model it is necessary to make some choices: to determine how to represent a problem, what kind of information the instruments we are using are capable of providing. Such a practice is necessary to get consistency between the formulation of a problem and the definition of the model adopted to resolve it.[12]

The transition from the classical science paradigm to that of the science of complexity emphasises the importance of an external subject in scientific and architectural research. According to Boltzam[13] and Pointcare[14], model-making is a subjective act. For John Holland, it is a creative reductionism.

The second property establishing similarity between scientific and architectural models (or diagrams) is reproducibility. In science, the importance of a model depends on its capacity to be reproduced in different situations. A feature of the reproducibility is the repeatability, namely the possibility to apply the same tool in similar conditions. This property transforms models in instruments of accumulation of intelligence and knowledge.
Indeed, the model becomes a heuristic device, or an interface supporting the designer's thinking.

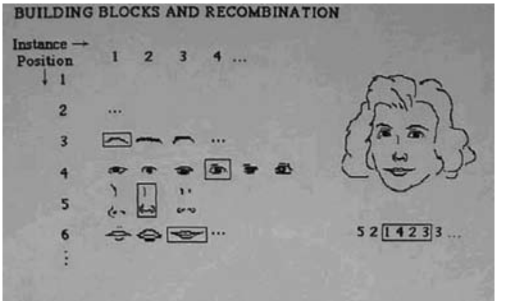


**Figure 2**
Combinatorial logic operates on the elementary units of a system by recombining them in a different aggregation. In the first case the recombination of the five elementary unit  or building blocks of the face of a person permits to achieve a very high number of variations. Image by courtesy of John Holland, from the lecture

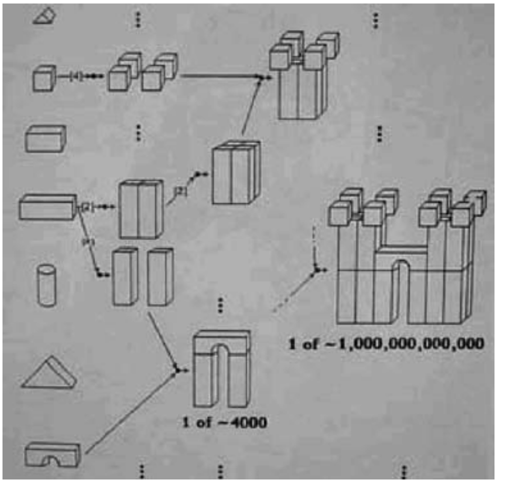


**Figure 3**
Combinatorial logic operates on the elementary units of a system by recombining them in a different aggregation. In this second case the recombination of the elementary units or building blocks of a building permits a very high number of variations. Image by courtesy of John Holland,

According to the French architect Bernard Cache, models are qualified by their capacity to define some invariants[15] or axioms that remain constant. The reproducibility of a model is the core of architectural problematisation of the model. To what extent is it possible to think about an instrument that is repeatable? How far is it possible to define an inner structure of a model remaining constant independently of the variations of the different case studies?
The interest of scientists and architects in the idea of codes, genetic algorithms, responsive devices and complex adaptive systems reflects the desire to obtain an instrument that is both stable in its internal organisation and capable of responding to changes in the exterior context by producing  specific solutions for every problem.[16] To explore the idea of the coexistence of innovation and repetition, it is possible to refer the ideas of Bateson[17] (in biology), of Holland (in cognitive science) and of Deleuze (in philosophy) to the concept of combinatorial innovation. The idea of combinatorial innovation relies on achieving innovation by recombining the internal elements of a system. This combinatorial process is determined by a set of rules (more or less deterministic) established by the designer.

When we engage with the topic of the change of paradigm in architectural research, the idea of robustness reveals another strong similarity between scientific and architectural models. Robustness is the capacity of a system to resist noises and distortions. It is through the evaluation of the robustness[18] of a system that a clear differentiation appears between models or diagrams and their translation into a symbolic language or a code. It is through the robustness that the change of paradigm has the strongest consequences. In effect the code is an expression in a symbolic language that operates through a set of rules. The code limits itself to accomplish exclusively the operations that have been explicitly stated.

The possible ambiguities in the message cannot be erased by use of the culture or the collective memory of its users. The code is not able to reveal any type of hidden information. Any missing or incomplete information, which normally could be integrated by human intervention, cannot be supplied by the simple application of the set of rules embedded in the code.

According to computer scientist William Wang, in the case of artificial language, it is almost impossible to process with software messages that any human being would understand immediately.

It is in its relation with robustness that a digital tool like the code differs from analogous apparatus such as a model or a diagram. The code is more rigid. The translation in a codified version of a specific language strongly affects its robustness or adaptive capacity to respond to noises and distortions.

Nevertheless, it is from its *non-robustness* or *non-adaptive capacity* that a very interesting peculiarity of scientific and architectural codes emerges. In effect, the codes can be used as creative and exploratory tool. Because they are executing the set of rules listed by its author, they are somehow self-sufficient: they are able to produce some results independently of the author or users. The application code is similar to the surrealists' use of *Automatisms*.[19] The code becomes a tool that is able to overcome the theoretical and formal level of its user barriers and self-censorship. Peter Eisenman says that automatisms by being self-sufficient can produce something far from any prefigured idea of the designer.[20]

The research Applied Responsive Devices aims to develop an innovative decision-maker tool enhancing architectural capacity to answer specific environmental and design requirements with its adaptable physicality. An Applied Responsive Device is a tool mediating between the potentialities of the analogous architectural model and the digital code.

ARD focuses on the qualitative and quantitative understanding of algorithmic, performative devices applied to the constructive reality of the built environment.

The NSU ARD research has the challenge of obtaining a repeatable and robust tool which can combine and mediate between mathematical performance data, the use of exploration and simulation software and empirical architectural applications.

As demonstrated in the projects *Responsive Devices 1, 2* and *3* developed by the NSU, architectural problems can be managed with a classifier system, consisting of a set of rules, each of which performs particular actions every time its conditions are satisfied by some piece of information.

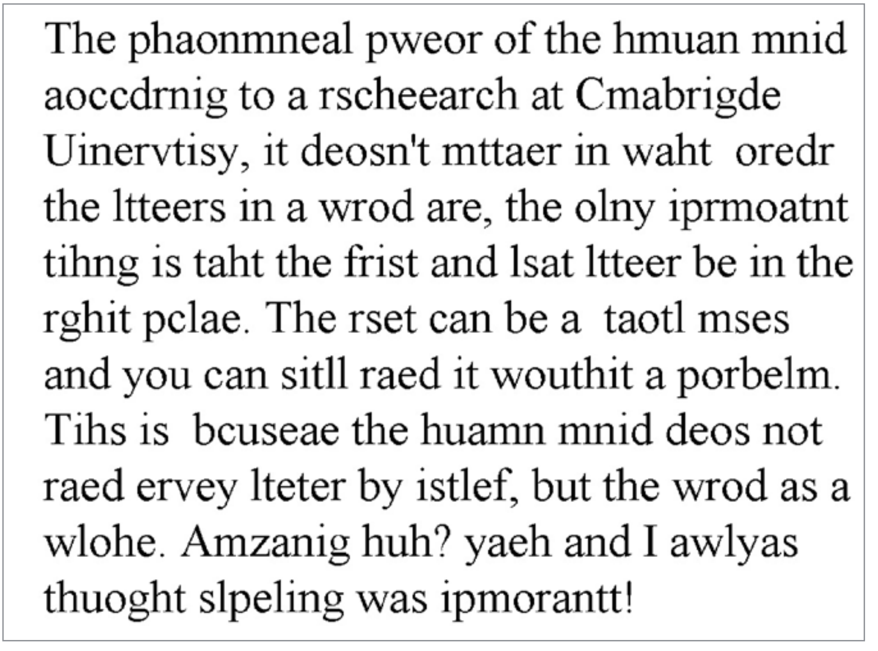

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**Figure 4**

Robustness

is the capacity of a system to respond to noises or alterations. The translation from analogical to digital model implies an increase of the fragility of the model. This image demonstrates how the human is capable of adapting to distortions of a message. This same condition is very difficult to obtain with a computer model. Image by courtesy of Y. Wang, presented at the Conference on Language as a Complex Adaptive Systems Santa Fe Institute, Beijing, in July 2005.

The methodological challenge is to develop a pilot model supporting the designer in the mediation between complex physical, social, economic and structural constraints and a formal response. The research questions the concepts of resemblance, repeatability, robustness and efficiency of the solution developed.

ARD is an adaptable device to unfold a set of formal solutions answering specific performance requirements. In every case study of the ARD research, the researchers enunciate the reasons why they are using a specific device to analyse (as in the case of ARD1 Copertura), to demonstrate or to explore (as in the case of ARD3 *Formal Modulation for Light Performance in a Women's Hospital*). ARD's first task is to obtain a deeper understanding of the way in which architectural information is processed, represented and organised, and then transformed into an abstract model. The method contained in this proposal investigates the existing relationships between the perception of a specific reality and its translation into a set of elements that can be manipulated through computerised models by engaging with the idea of resemblance and robustness.

The ARD research is supported by the study and collection of examples illustrating the logical connectionism that operates in the articulation of architectural projects through the definition of a set of associative and dynamic relationships.[21]
ARD research operates on two planes. On the theoretical level it is based on the selection of basic examples in which the architectural project can be expressed as a theoretical construct. Representing physical, structural or social processes, with a set of variables and a set of logical and quantitative relationships, ARD uses Holland's ideas of adaptation (Holland, 1992,1995,1997) for the typological evolution of the built environment in terms of adaptation to the external (site) conditions.
In order to achieve the logical model ARD, NSU researcher subdivides the process, into a system of elementary units: attributes and building blocks. Physical and conceptual problems are fragmented into attributes and building blocks. From a methodological point of view, in order to 'reduce' a specific reality into a set of elementary units, ARD refers to the experiences developed in other scientific fields.

This task requires the analysis of the conditions in which architectural needs and performances can be represented through sets of measurable units: attributes and building blocks. The presence or absence of a specific attribute would produce as output the appropriate behaviour (transformation of the physicality of the space, transformation of the process that affects the physicality.)
Expression of architectural principles is through a set of dynamical relations: articulation of the project in a set of relations and translation of the project input in an abstract symbolic language. The expression of architectural concepts through a set of dynamical relations can be synthesised in the following tasks: translation of architectural formal, functional and technological principles into a set of constraints; expression of the constraints identified in the previous phase in set dynamical relations, potentially through the employment of Agent-Based Models, Adaptive Models and Weighted Features (Livi, 2004).

ARD research is also based on the development of specific case studies in collaboration with other academic institutions and national architecture firms with the goal of consolidating and to refining the tools and methodologies detected in the theoretical research. Such an operation allows testing and verifying the resemblance and robustness of the ARD architectural model. The case studies have the goal of trimming and calibrating the ARD tool. They are also useful for analysing which tool is able to supply concrete answers and which of them can be operated with a satisfactory level of reliability.
The goal is to provide a set of key factors that lead to the formulation of indicators that enable the monitoring of relationships operating in the definition of the formal design, functional and engineering problems.

From an epistemological point of view ARD challenges the boundary between the measurable and the non-measurable architectural dimensions.

## Notes

1 Caterina Tiazzoldi. Adjunct Professor at the Graduate School of Architecture, Planning and Preservation at Columbia University, post doc researcher at the DIPRADI, Politecnico di Torino, Presented a PhD thesis on the topic of architecture and nonlinear strategies. She is the co-founder and co-director of the research lab Nonlinear Solutions Unit at the GSAPP, Columbia University NY, and teaches in various academies in the USA and Europe. Her work constantly challenges the boundary between the *Measurable* and the *Non-measurable* dimensions of architecture.

2 Caterina Tiazzoldi, *Automatismi o Strumenti Non Lineari di Progettazione*, PhD thesis, Politecnico di Torino ,May 2006.

3 John  Holland (2 February 1929) is an American scientist and Professor of Psychology and Professor of Electrical Engineering and Computer Science at the University of Michigan, Ann Arbor. He is a pioneer in complex system and nonlinear science. He is known as the father of genetic algorithms.

4 Cosma Shalizi, External Professor, Santa Fe Institute, Assistant Professor, Carnegie Mellon University, Statistics Department. Cosma Shalizi works on methods for building predictive models from data generated by stochastic processes, and applying those models to questions about neural information processing, self-organisation in cellular automata, and so forth. All of this is about using tools from probability, statistics and machine-learning to understand large, complex, nonlinear dynamical systems.

5 Eisenman P. Diagram Diaries, Thames & Hudson, London, 1999, p 27.

6 A classical example of this type of use of a model is when a medical doctor recognises a disease from the presence or absence of a chemical component in the blood: the interpretation of the 'blood components model ' allows him/her to demonstrate a hypothesis concerning the status of the patient.

7 Holland, J. Complex Adaptive Systems, lecture at the, CSSS 2005, Complex Summer School Systems, Beijing, 2005

8 '[…] It is a way of triggering the diagram as a trigger for their design process. The design process involves human beings and involves back and forward and going up where you have not been before. ' Peter Eisenman: Automatism in architecture; interviewed by Caterina Tiazzoldi  in July 2004.

9 Gilles Deleuze , (January 18, 1925 – November 4, 1995) was a French philosopher of the late 20th century. From the early 1960s until his death, Deleuze wrote many influential works on philosophy, literature, film, and fine art. His most popular books were the two volumes of Capitalism and Schizophrenia: Anti-Oedipus (1972) and A Thousand Plateaus (1980), both co-written with Félix Guattari. His books Difference and Repetition (1968) and The Logic of Sense (1969) led Michel Foucault to declare that "one day, perhaps, this century will be called Deleuzian."

10 'But unlike traditional forms of representation, the diagram as a generator is a Mediation between a palpable object, a real building, and what can be called Architecture's interiority' (Peter Eisenman, Diagram Diaries, Universe Publishing, 1999, P.35).

11 Peter Eisenman: Automatism in architecture; interviewed by Caterina Tiazzoldi in July 2004.

12 'So much for the praises of a moderate reductionism, alive to the importance of interactions. How do we actually set about reducing phenomena and explaining emergence? By constructing a model. What is a model? We can use one thing (say, a globe) as a model of another (say, the surface of the Earth) if we can find a way of translating, or, as the mathematicians say, mapping, from one to the other which doesn't mess up the relations we're interested in. Then anything we learn about the model can be translated into a discovery about the modeled.
(Holland includes things like the Game of Life among models, even though they do not fit this definition. Perhaps, like his board-games, they are to be regarded as models of imaginary worlds.) Models are only good if they're easier to handle and learn about than what they model, and if they really do accurately map the relations we're interested in. How does one find such a model?' Here Holland leaves us hanging, from the end of chapter two, on models, to the last chapters of the book. Despite having co-authored a whole (good) book on induction, his answer to the 'How?' question is 'Nobody knows.' He offers some sage advice --- become intimately familiar with the problem (no 'I could look that up'), learn the related problems and the tricks and the oral tradition which go

with them, be on the lookout for analogies and exploit them.
http://www.cscs.umich.edu/~crshalizi/reviews/holland-on-emergence/.

13 Ludwig Eduard Boltzmann (February 20, 1844 – September 5, 1906) was an Austrian physicist famous for his founding contributions in the fields of statistical mechanics and statistical thermodynamics. He was one of the most important advocates for atomic theory when that scientific model was still highly controversial.

14 Jules Henri Poincaré (April 29, 1854 – July 17, 1912) French mathematician and theoretical physicist, and a philosopher of science. Poincaré is often described as a polymath, and in mathematics as The Last Universalist, since he excelled in all fields of the discipline as it existed during his lifetime.
As a mathematician and physicist, he made many original fundamental contributions to pure and applied mathematics, mathematical physics, and celestial mechanics. He was responsible for formulating the Poincaré conjecture, one of the most famous problems in mathematics. In his research on the three-body problem, Poincaré became the first person to discover a chaotic deterministic system which laid the foundations of modern chaos theory. He is considered to be one of the founders of the field of topology.
Poincaré introduced the modern principle of relativity and was the first to present the Lorentz transformations in their modern symmetrical form. Poincaré discovered the remaining relativistic velocity transformations and recorded them in a letter to Lorentz in 1905. Thus he obtained perfect invariance of all of Maxwell's equations, the final step in the formulation of the theory of special relativity.

16 Combinatorial logic operating in the interior components of a system such as modules (building block) and attributes, in science as in architecture, provides innovative solutions. Image by courtesy of John Holland, from the lecture 'Genetic Algorithms and the Study of Complexity', Santa Fe Institute, Beijing, July 2005.

17 William Bateson (August 8, 1861 – February 8, 1926) was a British geneticist. He was the first person to use the term genetics to describe the study of heredity and biological inheritance, and the chief populariser of the ideas of Gregor Mendel following their rediscovery in 1900 by Hugo de Vries and Carl Correns.

18 Girvan M., Newman M.E.J., 'Community structure in social and biological networks', Proceedings of the National Academy of Sciences of the United States of America, 2002.

19 Automatism is a surrealist technique involving spontaneous writing, drawing or the like practised without conscious aesthetic or moral self-censorship. Automatism has taken on many forms: the automatic writing and drawing initially (and still to this day) practised by surrealists can be compared to similar, or perhaps parallel phenomena, such as the non-idiomatic improvisation of free jazz[1].
Surrealist automatism is different from mediumistic automatism, by which the term was inspired. Ghosts, spirits or the like are not suggested to be the source of surrealist automatic messages.

20 Automatism, being self-sufficient, is able to produce something far from the prefigured idea of the designer

21 For example, the work of architects such as John Frazer Frazer and Bernard Cache are focused on the expression of architectural problems through a set of associative relations bent on creating a direct connection between a specific reality and its representation (associativity).

**Matthias Haase, A. Amato**

# The importance of communication in concept design simulation

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# The importance of communication in concept design simulation

**Abstract**

The European Union has taken a strong leadership role in promoting energy efficiency in buildings. This is among other things highlighted by the Directive on the Energy Performance of Buildings, which is designed to promote the improvement of energy performance of buildings in member states. One of the benefits of this directive is that it provides an integrated approach to different aspects of buildings energy use, which until now only a few member states were doing, and that all aspects are expressed in simple energy performance indicators.

In order to achieve such reductions of the energy use in new buildings it will require development of new construction solutions, new types of building envelopes, and development of new building materials. It will also require the development of more holistic building concepts, sustainable buildings where an integrated design approach is needed to ensure a system optimization and to enable the designer(s) to control the many design parameters that must be considered and integrated. It is therefore important to understand how this design process works and how the architect can be enabled to integrate sustainable design solutions.

Computer-based modeling and simulation is becoming more and more significant for the prediction of future energy and environmental performance of buildings and the systems that service them. Modeling and simulation can and should play a vital role in building and systems design, commissioning, management and operation. Although most practitioners will be aware of the emerging building simulation technologies, yet few are able to claim expertise in its application.

In the design of sustainable buildings it is therefore necessary to identify the most important design parameters in order to develop more efficiently alternative design proposals and/or reach optimized design solutions. This can be achieved by applying sensitivity analysis early in the design process.

Previously, environmental simulation of building performance was only done by engineers at the end of the design process. Any weak points in the performance of the design could then be 'fixed' by adding heating, cooling, shades, vents, fans, panels, etc …

However, at the end of the design process it is too late. The decisions made early on in the design process have the largest impact. In addition, environmental issues are becoming more important, the complexity of the building design is increasing, and simulation tools are becoming more architects friendly.

Therefore, in the design of sustainable buildings it will be very beneficial to be able identify the most important design parameters in order to develop more efficiently alternative design proposals and/or reach optimized design solutions. Communication between architects and engineers

will become more common but also more important. Digital architecture has to take these challenges into account and develop a common language for architects that enable integrated design in order to tackle the problems stated above.

**Introduction**

There is a world-wide need for sustainable development (Behling 1996). There are basic explanations of what sustainable development is and how it is reached therefore in order to develop appropriate strategies for sustainable development in the built environment it is useful to review the key reports on sustainability issues.

*Brundtland Report*

The concept of sustainability was developed in the late 1980s. The World Commission on Environment and Development (WCED) in the Brundtland Report in 1987 defined sustainable development as "…development that meets the needs of the present without compromising the ability of future generations to meet their own needs". The report highlighted three fundamental components to sustainable development:

- environmental protection,
- economic growth and
- social equity.

The environment should be conserved and our resource base enhanced, by gradually changing the ways in which we develop and use technologies (Brundtlandt 1987). This idea is illustrated in Figure 1.

**Agenda21**

In 1992 The Earth Summit conducted under the auspices of the UN took place in Rio de Janeiro. The objectives were "to extend the provision of more energy-efficient technology and alternative/renewable energy for human settlements and to reduce negative impacts of energy production and use on human health and on the environment".
In order to be able to react in a flexible way to the diverse issues originating in the participating countries it was proposed to apply new concepts tailored to the local situation. "Think globally – act locally" was the resulting slogan (UNCED 1992). This emphasises the need for an analysis of the local situation of the built environment followed by developing sustainable solutions for that specific location.

*Kyoto protocol*

In 1997, governments from 188 countries adopted the Kyoto Protocol, under which they agreed to reduce their greenhouse gas emissions by the period 2008 to 2012. A large part of these emissions – 85 percent across Annex I countries in 1995 – arises from the production and use of energy. As a result, the commitments made in Kyoto will require significant reductions in energy-sector emissions in many countries ((Philibert and Pershing 2002; UNCED 1997).

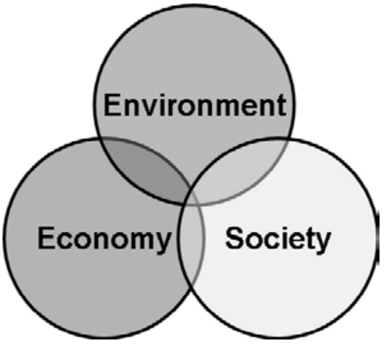


**Figure 1**
Sustainable development (Brundtland 1987)

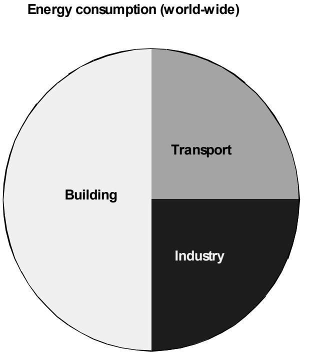


**Figure 2**
World-wide energy consumption distribution (Behling et al. 1996)

***UN World Summit on Sustainable Development (WSSD) (2002)***
The UN World Summit on Sustainable Development (WSSD) took place in Johannesburg, South Africa in 2002 and is also known as Rio +10 Summit because one of the two main goals was to review the progress on implementation of the 1992 Summit in Rio. The other goal was to develop a plan for the further implementation of sustainable development programs (UNEP 2002).

The primary Summit outcomes were
- the Johannesburg Declaration on Sustainable Development,
- the Plan of Implementation (The Plan of Implementation is designed as a framework for action to implement the commitments originally agreed at UNCED.),
- 283 Type II Initiatives (that are partnerships between government and different actors concerned with sustainable development).

*Sustainable building design*
Different countries have developed their specific vision of how to incorporate sustainable development in relation to the built environment.
The fundamental idea behind is that the built environment is responsible for 50% of energy consumed world-wide (Behling et al. 1996) as illustrated in Figure 2. Thus it is significant to reduce energy consumption of buildings.

The European Union has taken a strong leadership role in promoting energy efficiency in buildings. This is among other things highlighted by the Directive on the Energy Performance of Buildings, which is designed to promote the improvement of energy performance of buildings in member states. One of the benefits of this directive is that it provides an integrated approach to different aspects of buildings energy use, which until now only a few member states were doing, and that all aspects are expressed in simple energy performance indicators. The integrated approach allows flexibility regarding details, giving designers greater choice in meeting minimum standards. In order to achieve a certain degree of harmonisation of assessment of buildings for designers and users throughout the EU, a common methodology based on an integrated approach is established and includes the following aspects:

- thermal characteristics of the building;
- heating installations and hot water supply
- ventilation and air-conditioning installations;
- built-in lighting installations;
- position and orientation of buildings, including outdoor climate;
- passive solar systems, solar protection, natural ventilation and natural lighting;
- indoor climatic conditions, including the designed indoor climate;
- active solar systems and other heating and electricity systems based on renewable energy sources;
- district heating and cooling systems.

**Design**

In order to achieve such reductions of the energy use in new buildings it will require development of new construction solutions, new types of building envelopes, and development of new building materials. It will also require the development of more holistic building concepts, sustainable buildings where an integrated design approach is needed to ensure a system optimization and to enable the designer(s) to control the many design parameters that must be considered and integrated. It is therefore important to understand how this design process works and how the architect can be enabled to integrate sustainable design solutions.

Although many attempts to describe the design process have been made, there is no consensus or general theory about how design is handled. During the 80's design theory was developed, primarily through Schön's adaptation of Simon's ideas about modeling and simulation as the central activity in all design work (Simon 1969). Simon viewed design as the construction and use of models for developing a basis for the client's decision. He also argued that the designers first generate a set of alternatives and then test them against a set of criteria. In his renowned book: "Reflection in Action", Donald Schön presents design work as a dialectic between technical-rational thinking and intuition (Schön 1983). This theoretical argument has also been observed. "Essentially, design is a cumulative strategy of developing a solution and critically appraising it to see whether or not it meets the criteria of the client" Gray et al. presented observations (Gray et al. 1994). Bryan Lawson, in one of his books about design methodology, has made observations and descriptions of design processes. Among his main findings are that “There are no optimal solutions to design problems. Design almost invariably involves compromise.” and “Design inevitably involves subjective value judgments” (Lawson 1997).

Papamichael and Prozen proposed a new design theory along Schön’s lines, where they suggest that design involves “feeling and thinking while acting”, supporting the position that design is only partially rational (Papamichael and Protzen 1993). They claim that design decisions are not entirely the product of reasoning, rather, they are based on judgments that require the notion of “good” and “bad”, which is attributed to feelings, rather than thoughts. They further suggest that research and development efforts should concentrate on computer-based simulation of performance, factual databases and appropriate user interfaces (Papamichael et al. 1997). The new concept for computer-based design is based on the theory that building design is characterized by the following main stages:

- Generation of ideas and solutions (strategies and technologies)
- Performance prediction of potential solutions
- Evaluation of potential solutions

Within the work of the International Energy Agency, Task23 – Integrated Design Process, several design strategy methods and tools have been developed that try to optimize the building performance from the early design stage by including typical elements that are related to integration as

- Inter-disciplinary work between architects, engineers, costing specialists, operations people, and other relevant actors right from the beginning of the design process;
- Discussion of the relative importance of various performance issues and the establishment of a consensus on this matter between client and designers;
- Budget restrictions applied at the whole-building level, with no strict separation of budgets for individual building systems, such as HVAC or the building structure.
- The addition of a specialist in the field of energy, comfort, or sustainability;
- The testing of various design assumptions through the use of energy simulations throughout the process, to provide relatively objective information on this key aspect of performance;
- The addition of subject specialists (e.g. for daylighting, thermal storage etc.) for short consultations with the design team;
- A clear articulation of performance targets and strategies, to be updated throughout the process by the design team.
  (Larsson and Poel 2003)

An integrated design approach has impacts on the design team that differentiate it from a conventional design process in several respects. The client takes a more active role than usual; the architect becomes a team leader rather than the sole form-giver; and the structural, mechanical and electrical engineers take on active roles at early design stages. (Larsson and Poel 2003)
Within the framework of the IEA Annex 44 project examples of methods and tools that are used

in the design of integrated building have been described as shown in Table 1. Although the report did not aspire to give a complete overview of all possible design methods and tool it contains a description of 11 different methods and tools that are widely used in research and development work (Annex44 2006a).
Although the methods contain many similar aspects, they may be organised into 5 main categories:

- Design Process Methods/Tools
- Design Evaluation Methods/Tools
- Design Strategy Methods/Tools
- Design support Methods/Tools
- Simulation Tools

There are no sharp borders between the different types of tools. The design support tools may in some case also be used as design evaluation tools, and vice versa. The available computer simulation tools for predicting energy use and indoor climate are typically used as design evaluation tools, but may also be used as design support tools (Annex44 2006).

*Architectural consequences*
The building design is the first and most important step in developing an environment that fulfils the main key demands. The OECD project on sustainable buildings for the future identified five objectives for sustainable buildings (John 2005):

- Resource efficiency;
- Energy efficiency (including greenhouse gas emissions reduction);
- Pollution prevention (including indoor air quality and noise abatement);
- Harmonization with environment;
- Integrated and systemic approaches.

The background of these keywords range from ecological, environmental to technical, engineering topics. The role of the architect is to incorporate all these issues into the early design since this provides the largest benefits as illustrated in Figure 4.
The architect is not educated to deal with all of these issues. Resource and energy efficiency and pollution prevention are typical fields of engineering application. Harmonization with the environment is multidimensional and most architects deal with this task but is there an integrated and systematic approach to reach a sustainable building?

In this respect is important to educate architects and engineers on the:

- Energetic consequences of design
- Quantity of architectural concept
- Quantity of architectural quality
- Quality of energetic concept
- Architectural consequences of energetic concepts

| Name | Origin | Year |
|---|---|---|
| The Integrated Design Process, Task 23 | IEA SHCP Task 23 (International) | 2003 |
| The Integrated Design Process, Knudstrup | M-A.Knudstrup, Aalborg University, Denmark | 2004 |
| Integrated Building Design System, IBDS | K.Steemers, Cambridge University, UK | 2005 |
| The Eco-Factor Method | Erik Bjørn, Åsa Wahlström (Swedish National Testing and Research Institute, Henrik Brohus (Aalborg University) | 2004 |
| Trias Energetica | Ad van der Aa, Ir. Nick van der Valk, Cauberg-Huygen Consulting Engineers, The Netherlands | 2005 |
| Energy Triangle | Haase, M. and A. Amato, Hong Kong University | 2005 |
| The Kyoto Pyramid | T.H. Dokka, SINTEF, Norway | 2004 |
| E-Quartet | A. Satake, Maeda Corporation, Japan | |
| Eco-Facade | M. Kolokotroni (et al), Brunel University, UK | 2004 |
| LEHVE | T. Sawachi, NILIM, Japan | 2005 |
| VentSim | S. Nishizawa, Building Research Institute, Japan | |

**Table 1**

Different methods and tools that are widely used in research and development work (Annex44 2006c)

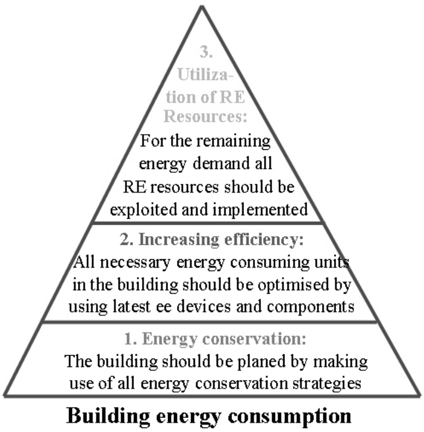


**Figure 3**

Energy triangle for sustainable building design (Amato and Haase 2005)

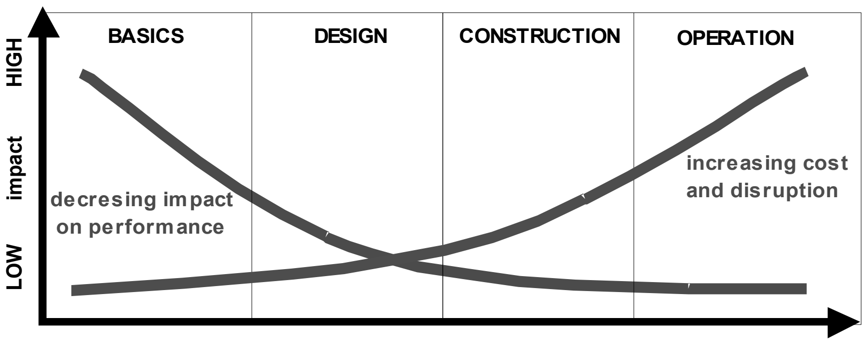


**Figure 4**

Benefits of early decisions

Here it becomes obvious that a main task of future architectural research should focus on quantifying architectural qualities and qualifying engineering quantities. This has to begin with the development of a common language for architects and engineers.

**Simulation**

For the purposes of discussion, the use of computers can be divided into the following categories:

- numerical analysis,
- symbolic manipulation,
- visualization,
- simulation, and the
- collection and analysis of data.

Numerical analysis refers to the result of well-defined mathematical problems to produce numerical (in contrast to symbolic) solutions.
Over the past two decades, the building sim
ulation discipline has matured into a field that offers unique expertise, methods and tools for building performance evaluation. It draws its underlying theories from diverse disciplines, mainly from

- physics,
- mathematics,
- material science,
- biophysics,
- human behavioral,
- environmental and
- computational sciences.

Computer-based modeling and simulation is becoming more and more significant for the prediction of future energy and environmental performance of buildings and the systems that service them. Modeling and simulation can and should play a vital role in building and systems design, commissioning, management and operation. Although most practitioners will be aware of the emerging building simulation technologies, yet few are able to claim expertise in its application. This situation will soon be improved due to developments and activities such as

- Introduction of performance-based (EU) standards – as opposed to prescriptive standards – in areas such as energy consumption, quality of the indoor environment, etc.
- Establishment of societies dedicated to promotion and the effective deployment of simulation such as the International Building Performance Simulation Association (IBPSA).
- Growth in small-to-medium-sized practices offering simulation-based services.
- Appropriate training, continuing education, and incorporation in the regular curricula of (higher) educational institutes.
  (Hensen et al. 2002b)

Theoretical challenges are plentiful when recognizing that the physical state of a building is the result of the complex interaction of a very large set of physical components. The integration of these interactions in one behavioral simulation poses major modeling and computational challenges. Its ability to deal with the resulting complexity of scale and diversity of component interactions has gained building simulation a uniquely recognized role in the prediction, assessment and verification of building performance. The building simulation discipline is continuously evolving and maturing and improvements are continuously taking place in model robustness and -fidelity. As a result, the discussion has shifted from the old agenda that focused on software features to a new agenda that focuses on the effectiveness of and team based control over simulation tools in building life cycle processes (Hensen and Nakahara 2001).

A lot of research is devoted to the better description, modeling and simulation of physical transport flows in buildings such as the flow of energy and matter as well as radiative transport phenomena such as light and sound. Applications of such studies deal with the simulation of energy conservation and storage systems, dynamic control systems for smart building technologies, optimal performance of heating and cooling devices, visual and acoustic comfort, smoke and fire safety, distribution of air borne contaminants, the growth of molds, and others. It is expected that new developments will radically influence the way that simulation is performed and its outputs used in design evolution and post occupancy decision making (Hensen et al. 2002a). Apart from this shift from simulation of phenomena to design decision making, there are a number of major trends, such as the shift from the need for “raw number crunching” to the need for support of the “process of simulation”, and from “tool integration” to the “process of collaboration” (Augenbroe and Hensen 2004).

In this context, most traditional design tools are not particularly useful for analysis at concept stage, for a number of important reasons:

- There is no easy way of imbuing objects in the model with real architectural knowledge.
- CAD models have no concept of spaces and zones, they exist solely as a by-product of the layout of disassociated polygons and prisms.
- Whilst it is possible to assign tokens and indicators to individual objects, it is not possible to apply detailed thermal, lighting and acoustic material properties.
- Even if you could work out a way of embedding any of this data, most analysis engines will only read in a DXF file anyway, which will completely ignore this embedded data.

There are also a number of problems with using simulation software:

- It changes the way that the design must be modeled
- It is complex to learn; requires a lot of knowledge
- It favours conventional building types
- Is restricted in the types of geometries that can be modeled
- It can be inaccurate

Many different types of software system have been developed to evaluate buildings.
For example:

- Environmental impact analysis (e.g. embodied energy within materials)
- Cost analysis (e.g. fabric cost calculation)
- Structural analysis (e.g. structural stability)
- Environmental simulation (e,g, lighting, energy, acoustics)
- User behaviour simulation (e.g. people flow)

Linking the simulation process to the design process is a very important step. There has not been enough research on this aspect. A new framework of applying simulation tools into conceptual design stage was proposed (Xia et al. 2008). Several issues have been evaluated, including

- the subdivision of the conceptual design stage and their characteristics,
- the architects' requirements on the building simulation tools in each sub-stage,
- the available information for the building simulation in the different sub-stages, and
- the simulation procedure assisting the conceptual design.

What is missing in this programme is a further link to other aspects in conceptual design, e.g. programme (building use defined in design brief), environmental programme (incl. area and infrastructure, material use, etc.) (Støa et al. 2006) and architectural quality. Here, more architectural research is necessary in order to evaluate architectural consequences of low-energy measures that enable the designer to fully explore the possibilities (Kleiven 2004).

*Robustness*

In the design of sustainable buildings it is therefore necessary to identify the most important design parameters in order to develop more efficiently alternative design proposals and/or reach optimized design solutions (Heiselberg 2006). This can be achieved by applying sensitivity analysis early in the design process. A sensitivity analysis makes it possible to identify the most important design parameters in relation to building performance and to focus design and optimization of sustainable buildings on these fewer, but most important parameters (Lam and Hui 1996; Lomas and Eppel 1992; Saltelli et al. 2000). A sensitivity analysis will typically be performed at a reasonably early stage of the building design process, where it is still possible to influence the selection of important parameters.

Thus, sensitivity analysis and robustness studies make it possible to identify the most important design parameters for building performance and to focus the building design and optimization on these fewer parameters.
The main barrier for application of sensitivity analysis in building performance assessment is the increase in calculation time and complexity (Heiselberg 2006).

Table 2 shows the results of a recent study carried out at SINTEF. It illustrates the impact of different design parameter of a typical office building in Norway. A robustness factor has been

| Design | Parameter | description | RI = (IP value that changes OP 10%) | |
|---|---|---|---|---|
| **External** | | | | |
| | Climate | annual average temperature | 1.62 | [°C] |
| | Horizon | degree | | |
| **Building** | | | | |
| | Air tightness of envelope | air leakage | 1.48 | [ach at 50 Pa] |
| | Orientation | degrees | | |
| | U-value | floor | 42.3 | [W/m$^2$/K] |
| | | roof | 0.28 | [W/m$^2$/K] |
| | | wall | 0.33 | [W/m$^2$/K] |
| | Windows/glazing type and size | U-value | 0.89 | [W/m$^2$/K] |
| | | WFR | 0.12 | [-] |
| | Shading and daylighting systems | Fs | 1.63 | [-] |
| **Technical** | | | | |
| | Efficiency of heat recovery system | $\mu$ | 0.12 | [-] |
| | heating capacity | Ch | 212 | [W/m$^2$] |
| | Occupancy | persons/m$^2$ | 0.27 | [pers./m$^2$] |
| | cooling set point temperature | set point temperature | 1.34 | [°C] |
| | Heating set-back temperature | set-back temperature | 4.31 | [°C] |
| | lighting load | Inst. load | 6.07 | [W/m$^2$] |
| | Equipment load | Inst. load | 5.91 | [W/m$^2$] |

**Table 2**

Results robustness study

calculated that identifies the robustness of various input parameter. It can be seen that e.g. the change of the U-value of the roof of 0.28 W/m$^2$/K results in a 10% change in annual energy consumption under south Norwegian climate conditions.

A robustness index has been proposed for each design parameter which can help to rank the importance in building design (Haase and Andresen 2008). For a typical office building design in Norway the robustness index gave more insight to which extend design parameter influence annual energy consumption (see Table 2).

*Integration*

AS mentioned before to achieve such reductions of the energy use in new buildings it will require development of new construction solutions, new types of building envelopes, and development of new building materials. It will also require the development of more holistic building concepts, sustainable buildings where an integrated design approach is needed to ensure a system optimization and to enable the designer(s) to control the many design parameters that must be considered and integrated.

In this context, Whole Building Concepts are defined as solutions where reactive building elements together with service functions are integrated into one system to reach an optimal environmental performance in terms of energy performance, resource consumption, ecological loadings and indoor environmental quality. Reactive Building Elements are defined as building construction elements which are actively used for transfer of heat, light, water and air. This means

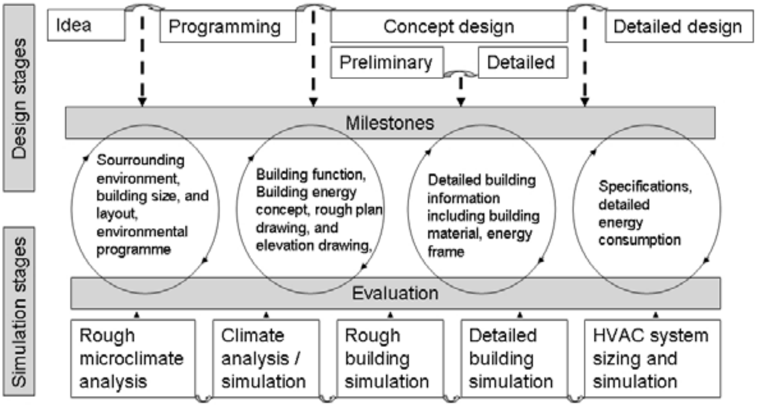


**Figure 5**

Linking design and simulation in the conceptual design stage (modified from Xia et al.)

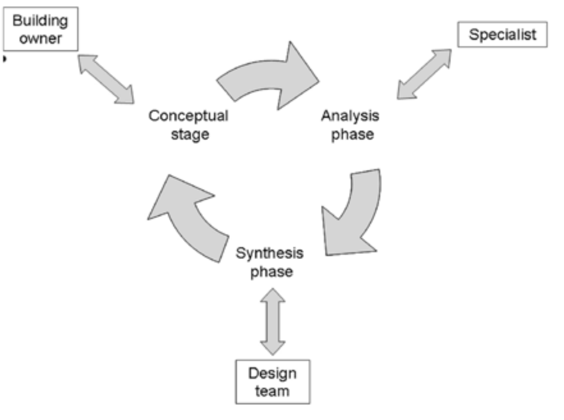


**Figure 6**

A different approach to concept design (modified from Knudstrup 2004)

that construction elements (like floors, walls, roofs, foundation etc.) are logically and rationally combined and integrated with building service functions such as heating, cooling, ventilation and energy storage. The development, application and implementation of reactive building elements are considered to be a necessary step towards further energy efficiency improvements in the built environment (Annex44 2006b).

With the integration of reactive building elements and building services, building design completely changes from design of individual systems to integrated design of "whole building concepts, augmented by "intelligent" systems and equipment. Development of enabling technologies such as sensors, controls and information systems are needed to allow the integration. Design strategies should allow for optimal use of natural energy strategies (daylighting, natural ventilation, passive cooling, etc.) as well as integration of renewable energy devices (Annex44 2006b).

The annex will, based on the knowledge gained in the work so far (particularly the results of IEA Annexes 32, 35 and 37, SHC Task 23), address the following objectives:

- Define state-of-the-art of reactive building elements
- Improve and optimize reactive building elements and technologies
- Develop and optimize new building concepts with integration of reactive building elements, building services as well as natural and renewable energy strategies
- Develop tools for the early assessment of the impact of reactive building elements on the environmental performance of buildings
- Develop guidelines for procedures and tools for detailed simulation of environmental performance of reactive building elements and integrated building concepts

Architects should have a basic understanding of the role of building elements in whole building concepts. They need to be able to communicate with specialized engineers on certain topics and to moderate the discussions between various engineering domains.

**Conclusions**

Previously, environmental simulation of building performance was only done by engineers at the end of the design process. Any weak points in the performance of the design could then be 'fixed' by adding heating, cooling, shades, vents, fans, panels, etc … However, at the end of the design process it is too late. The decisions made early on in the design process have the largest impact. In addition, environmental issues are becoming more important, the complexity of the building design is increasing, and simulation tools are becoming more architects friendly.

Fundamental to the development of concept design tools is the notion that environmental design principles are most effective when considered during the earliest most conceptual stages of the building design process. The conceptual stage of design occurs at the very beginning, when the brief is still being analyzed and decisions regarding

- geometry,
- materials and
- siting

are still to be made.

This is also the stage most ignored by traditional building analysis and simulation software, primarily because hard quantifiable data describing the building simply doesn't exist. The architects role in this implies also a fundamental understanding of the architectural consequences.

What is needed is calculation feedback and its support for very early stage conceptual design (ideally of visual nature) as well as final design validation. Designers must start generating vital performance-related design information before the building form has even been developed. It must be possible to start a detailed climatic analysis to calculate the potential effectiveness of various passive design techniques or to optimize the use of available solar, light and wind resources. It must further be possible to test these ideas on some simple sketch models before gradually developing up the final design. This would give the designer the possibility to evaluate his design and adjust it to the situation. Two methods can be used which are illustrated in Figure 7 and 8.

The architect should be able to:

- Energetic consequences of design
  - Perform daylight analysis
  - Understand energy concepts
- Quantify architectural concept
  - Perform heating and cooling load calculation
  - Calculate monthly heat loads and hourly temperature graphs
  - Generate full schedules of material costs and environmental impact
- Quantify architectural quality
  - Display and animate complex shadows and reflections
  - Generate interactive sun-path diagrams for instant overshadowing analysis
  - Calculate the incident solar radiation and its percentage shading
  - Work out daylight factors and artificial lighting levels spatially and at any point
  - Etc.

Therefore, in the design of sustainable buildings it will be very beneficial to be able identify the most important design parameters in order to develop more efficiently alternative design proposals and/or reach optimized design solutions. Communication between architects and engineers will become more common but also more important.
Digital architecture has to take these challenges into account and develop a common language for architects that enable integrated design in order to tackle the problems stated above.

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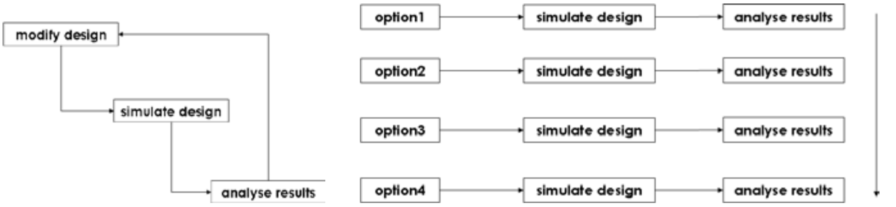


**Figure 7**

Two different design modification feedback methods

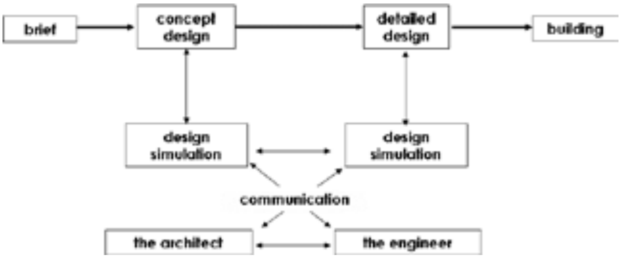


**Figure 8**

Communication between architect and engineer in design phases


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# Interleaving Semantics for Multi-Disciplinary Collaborative Design

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# Interleaving Semantics for Multi-Disciplinary Collaborative Design

**Abstract**

'Collaboration is an important aspect of the architects' education.' (Kalay, Jeong 2001). The teaching of architectural design is facing with increasing urgency those aspects of the pedagogy related to the collaboration within the learning activity. The legacy of design as problem solving has been to consider collaboration a problem of effective communication where massive amounts of data must be shared among heterogeneous participants. Therefore, achieving interoperability among different CAD systems by way of organizing efficient databases has been the core research issue. The initial effort started with standardizing product descriptions including geometric information and constructing databases to organize them. The underlying theoretical assumption of these efforts is that *a building is a product composed of the heterogeneous products.*

This assumption has been relatively valid and even successfully realized in several related industries, such as the automotive and shipbuilding manufacturing industries. However, the building and construction industry continues to lag behind in this development because constructing a centralized product database has turned out to be not feasible because the shared database quickly becomes too large and unwieldy to support the dynamic process of multi-disciplinary collaborative design.

In contrast to the failed centralized database model, we propose to develop a distributed model, where each domain of expertise retains its own data in the form most appropriate for its needs, and where 'intelligent' filters translate data into and from a neutral data structure. The discipline-specific filters will transform the neutral representations into semantically-rich ones, as needed by their domains of expertise. Conversely, they will translate semantically-rich, domain-specific data into a neutral representation that can be accessed by other domain-specific filters. To the participants, therefore, the data they see will appear semantically rich, even when it was generated by another professional, thereby facilitating a high level of shared understanding. We also develop a computational methodology that will prove that computer-analyzed and generated design suggestions can actually help designers to achieve their goals better and/or faster. It will also let them know ahead of time what will be the implications of their proposed actions, as seen from other participants' points of view. Once the participants contribute their knowledge to the representation, it would be possible that each of them could see the other's point of view.

The dynamic and semantically-rich representation would allow incoherent/favorable situations to be highlighted and managed in real time and the participants to make alternatives reflecting their intents more effectively. The impact of a network-based collaborative design transforms a hierarchical/linear partitioned process into a distributed and interleaved one. In the filter medi-

ated communication model, the participating professionals can affect one another bi- or multi-directionally.

We propose the filter mediated communication model and its process to reflect the characteristics of multidisciplinary collaborative design without sacrificing human-centered aspects, and to solve real-world collaboration problems by focusing on a semantically rich representational method at three different levels that are mediated by intelligent filters. By fulfilling the discussed tasks, the experts from different disciplines participating in an AEC project are expected to better understand the dynamic process of design, to achieve a high level of shared understanding. and to facilitate the onset and dissemination of creative ideas.

**Introduction**

The legacy of design as problem solving has been to consider collaboration a problem of effective communication where massive amounts of data must be shared among heterogeneous participants. Therefore, achieving interoperability among different CAD systems by way of organizing efficient databases has been the core research issue. The initial effort started with standardizing product descriptions including geometric information and constructing databases to organize them. Following the standardization of product model data, Eastman (1991) proposed Engineering Data Model (EDM) to manage heterogeneous information carried by different design and engineering applications.

The underlying theoretical assumption of these efforts is that *a building is a product composed of the heterogeneous products.* This assumption has been relatively valid and even successfully realized in several related industries, such as the automotive and shipbuilding manufacturing industries. However, the building and construction industry continues to lag behind in this development (Tolman 1999). In the following sections, we will examine the Building Product Model (e.g., ISO-STEP, IAI-IFC) and its problems, and discuss the Filter Mediated Communication Model as an alternative approach.

**Building Information Modeling**

*Building Product Models*

In the 1970s, the National Institute of Standards and Technology (NIST) proposed a standard for the exchange of massive geometric data, called the Initial Graphics Exchange Standard (IGES), which defined a neutral data format as the lowest common denominator among CAD systems that use it. While IGES has been developed and maintained by a governmental agency, Data eXchange Format (DXF) has been developed by Autodesk in order to meet customers' needs. The technical objective of this approach is to transfer one CAD system's data to another and vice versa through the least amount of data extracted from available CAD systems and other engineering applications. However, as CAD systems grew more diverse and sophisticated, this approach soon revealed its limitation. The most notorious problem is that when one application's data is translated into one of the neutral file formats, the translated data is no longer consistent with the original data because it loses the semantic information which was relevant to the application.

The complexity of the file formats is another problem. Both IGES and DXF require solid professional programming skills to understand and manage. These weaknesses were not easily corrected so that searching for a new method was accelerated. With this motivation, the International Standards Organization (ISO) developed an international standard in 1984, known as the Standard for the Exchange of Product Model Data (STEP) for computer-based description and exchange of physical and functional characteristics of products throughout their life cycle, independent of any particular system. A product model is an information model that implicitly contains data regarding form and function of a product and aims at describing the targeted product through its life cycle. A building product model is an example of a product model in the AEC industry, which can describe the form (e.g., geometric information and its relationships) and function (e.g., energy performance) of a building through its life cycle. Recently, these efforts were reincarnated as Building Information Modeling (BIM) driven by several CAD system vendors (Autodesk, GraphiSoft, Bentley, etc.).

*Industry Foundation Classes*

The newest and largest effort is collectively known as the Industry Foundation Classes (IFCs), published by the International Alliance for Interoperability (IAI) in 1995.

The IFC is an open and non-proprietary data model specification in the AEC industry representing a fixed set of objects commonly used for the built environment. IFCs are used by computer applications (not intended for humans) to assemble a computer processable model of the facility that contains all the information of the parts and their relationships to be shared among project participants.

The philosophy of the IFCs is to electronically represent all possible aspects of a building including products (e.g., doors, walls, fans, etc.) and abstract concepts (e.g., space, organization, process etc.). These specifications represent a data structure supporting an electronic project model useful in sharing data across applications. Each specification is called a 'class.' The word 'class' is used to describe a range of things that have common characteristics. For instance, every door has the characteristic of an opening to allow entry to a space; every window has the characteristic of transparency so that it can be seen through. Door and window are names of classes.

The classes defined in the IFCs model can be used in designing a structure, in costing and scheduling, in providing critical data appropriate for contractors and subcontractors, in evaluating energy performance, or allowing facility managers and building owners to access data pertinent to their business.

*Problems and Limitations of BIM*

For the past few decades, it appeared that such product models could serve the purpose of collaborative design. Eastman (1997, 1998) proposed a universal building model, which was an attempt to support multiple designers using different applications forming an effective multi-user collaborative design environment. It is based on a central model that can be either partially or entirely shared by participants, and specific design 'views' which are defined as units of organization specific to each participant.

Although his approach supports different views, it is focused on converting and updating the integrated model from multiple sources at the level of the applications themselves into a generalized description of the entire building. Eastman's, and other centralized data models, were well defined and tractable enough to support a limited number of participants. However, the complexity of the architectural product has generated more problems than the shared data model could solve. The IAI have also identified the most time consuming aspects of their IFC definition problems as follows (Wix et al.):

- Ensuring as wide an agreement as possible within the industry on semantic definitions.
- Obtaining model reviews, handling the issues that result from review and ensuring that issues resolution is open for all members to see.
- Integrating all domain developments into a single model that is internally self consistent.
- Ensuring technical consistency across the whole of the model and all of its supporting documentation.
- Providing guidance to implementers to ensure minimum ambiguity within the model.
- Developing the necessary testing mechanisms to ensure that there is a means of guaranteeing compliance of software with the objectives of IFC design.

The listed difficulties would be true of all the integrated model approaches. It has become clear that a single data model would not be able to serve all the requirements of all the participants. In addition, the sheer magnitude of the combined data often exceeds the capability of its management by any one domain. Although an integrated model was expected to achieve interoperability among different domains of expertise, it actually exacerbated their fragmentation and the symmetry of ignorance.

The nature of architectural design has proven to be an obstacle to the kind of utopianism embodied in the data-centric approach. It can be likened to the making of a puzzle, where designers search for individual solutions (spatial, structural, material, economical, etc.) that can fit together in some spatio-temporal context. It is an iterative, dynamic process, where propositions are made and tested against goals and constraints that are both internal to each domain of expertise, as well external to them (i.e., originating in other domains).

**Filter Mediated Communication Model**

*Rationale*

When the participants in a design process make decisions and negotiate with one another, they use their own representations, knowledge, methods, and resources. Take three participants in the design of an office building: an architect, a structural engineer, and a mechanical engineer. The architect designs an initial layout and one or more lists of requirements and constraints, using his own representational methods. The architect "publishes" the drawings in a way that can be "read" by the structural engineer. Based on the architect's input, the structural engineer designs the structure of the building using his own knowledge and method of representation. The structural or mechanical engineer most likely will review the architect's drawings first, and design the structure or HVAC using structural or energy codes and standards as well as his own disciplinary tool. Once his design is ready, the engineer "publishes" his design. However, if he is unable to design within the range of the architectural drawings, the participant will ask the others for modifications. This scenario is, of course, only a brief description of a rather lengthy and iterative process, highlighting only three of the many participants. It can be easily complicated by adding more participants. However, it sufficiently shows how each participant in the process alternates between their 'private' representations, used during their own, internal design process, and the 'public' version which they 'publish' for the benefit and use of the other participants.

The core of collaboration arises when all the actors can see the different views within the structure of the product's model as a whole, analyze their inconsistencies, understand each others' reasons and see their effects on the whole as well as on their view, evaluate others' proposals, assess the possible trade-offs, and eventually modify their own view.
This kind of process has to be directly interactive, in order to allow what can be called a "mute discussion". Two requirements are therefore requested: a complex representation of the shared model, structured by views and including objects and mutual relationships; a means to mediate a confrontation among different (or concurrent) ideas of the different actors. The representation of the product's model as a whole in the SDW is thus a complex one, as much structured as possible, and in the meantime must be poor enough ("lean" model) to be understandable by all. To allow the process to be truly collaborative, modifications should be targeted and real-time interactive, mainly in the "creative" moments; any actors may well not know why another one has done a modification but they certainly have to understand the effects, mainly for what they are concerned.
We assume a kind of 'filtering' mechanism mediates between the private (domain-specific) workspace and the shared public workspace. This filter strips the published version from each of the participants' private notations, sketches, calculations, and other design representations that the participant uses during the design process, and which would be of no use to the other participants. A similar but inverse filtering occurs when each participant receives the input generated by the others, and interprets and translates it into their domain-specific representation.

We contend that it is this 'filter' where much of the essence of collaborative design resides. It is the process which adds disciplinary knowledge to input received from other participants, and which makes each participant's own discipline-specific representations easier to comprehend by the others (much like a perspective drawing is a form of representation that makes it easier for the client to understand the architect's design). The 'filter' is thus a bridge between the private workspace of each participant, and the public, shared workspace. In the public space, the object level of information exists, which includes geometric and non-geometrical data as well as semantic data attached to them. In the private space, there exist two levels: the conceptual and the mechanical level. The participant's tacit knowledge and beliefs are in the conceptual level. In the mechanical level, ontology (a formal specification in the conceptual level), value systems (the subjective and disciplinary value in which each expert views the performance of the product), and various tools exist. The filter mechanism operates on top of these two levels.

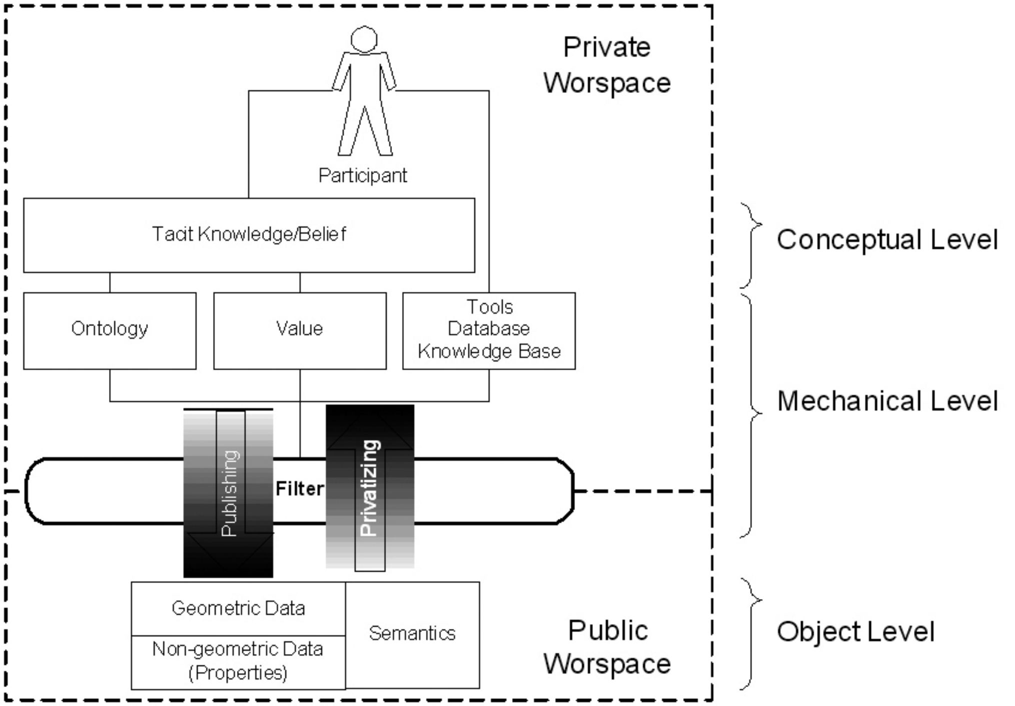


**Figure 1**
Anatomy of a discipline

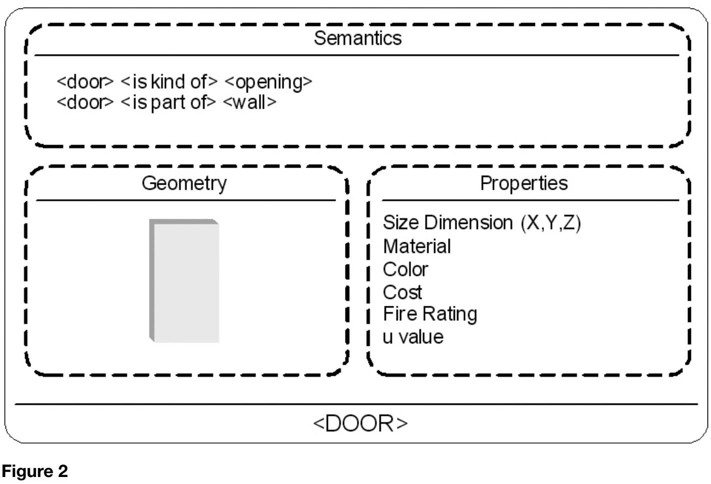


**Figure 2**
An ontology of "DOOR"

This approach matches conventional multi-disciplinary design processes. In conventional design processes, such 'filters' are the knowledge used by each of the participating professionals. It differs from the data-centric models of collaboration in that it uses no centralized database. Rather, the project data is a collection of the individual contributions of the participants. If any one of the participants wishes to see data produced by another participant, they have to retrieve the relevant information from that participant then translate it into its own representational form within its own workspace. The entire project can thus be regarded as a compilation of each individual's own representations. It comes from the *interleaving*, of the 'filtered' private views linked by their mutual relationships.
Each one of the participants is responsible for authoring their own representations, and for retrieving the latest version of the design produced by the other participants. At any stage, but at the very end of the design process, each contribution can be incoherent, thus the solutions displayed in the shared workspace can be inconsistent both inside and among themselves. The role of the 'filter' is to facilitate the participants work, *mediating* their different representational forms and supporting the *integration* of their individual contribution on the shared product.

*Ontology as an Extended Representation*

The filter operates as an autonomous entity – an agent – that can take on partial responsibility for exchanging information with other computational or human experts who have domain-specific knowledge. To do so, the filter uses its own built-in domain-specific knowledge. That knowledge is represented as an ontology – a concept borrowed from philosophy and given a specific technical meaning in computer science. An ontology is a formal, explicit specification of a shared conceptualization: a common vocabulary and model of some concept or entity (Gruber 1993). An ontological framework can be used by a set of actors (humans, software applications, artificial agents) so that they can communicate about the domain of discourse without necessarily using a globally shared theory (Katranuschkov, 2003). In the context of the AEC industry, an ontology can define a set of representational terms in some knowledge domains (architecture, structural engineering, mechanical/ electrical/plumbing, construction, etc.).
These definitions associate the entities of the domain of discourse (walls, doors, columns, beams, joints, bearing structures, and the like) with human-readable text describing what these entities mean, and formal axioms that guide and constrain the interpretation and the use of the terms. Thus, an ontology adds to the descriptive data logical statements about the nature of the described entity itself. For example, if a data model describes a door in terms of its geometry, material, cost, and other descriptive parameters, an ontology of doors adds concepts like controlled passage, lockability, and the (necessary) relationship between a door and the wall in which it is embedded. This expanded description provides a common vocabulary that defines meaningful queries and assertions about the represented entity (e.g., does the door retain its 'doorness' when it is disassembled from the wall in which it is embedded, and used as a table top?).
To be more explicit, let us consider what may happen when information about a door is needed, for example, to check its code compliance for fire egress. In a data-centric (e.g. IFC-based) environment, this information would be stored in a shared project repository as a DOOR object

and a number of related resource objects, such as MATERIAL, PROPERTIES, SHAPE, etc. An appropriate query can easily be formulated, even answered. However, the answer might be meaningless, if the door is not located in a wall, or it is locked or blocked and cannot afford egress. In contrast, the ontology approach would allow us to define the concept of a door fully, in a manner that does not depend on the 'intelligence' of applications that use it. It would provide the sufficient means to execute operations on door objects, and interpret the results of these operations correctly. Furthermore, it would be possible to define the 'door' object itself for a specific context. Any geometric object with specific properties including performance can be regarded as a door (Figure 2).

The door ontology describes not only geometric/non-geometric information, but also the semantics, which enables to retain the underlying ideas. According to the semantics of the door ontology in Figure 2, a door can retain its doorness only if it is embedded in the specific wall.

To fulfill its desired function as a means of high-level communication among the participants in an AEC collaborative design project, the filter must behave in an intelligent manner. It must operate both at a syntactical level (i.e., allow different applications to read the data), as well as on a semantic level (i.e., convey the ontological meanings associated with the data). More specifically, we have identified two different levels of communication in the object level:

- Semantic level – expressing ontologies and relations (internal or external mappings) for a particular domain.
- Syntax level – machine-processable format, such as XML.

*Semantic Level*

The semantic level is the first step towards inter-domain communication. It adds to the object data the conceptual ontology that any one domain expert may take for granted, but which would be viewed differently by another domain expert. It thus provides a more explicit, but abstract way to describe information, encapsulating both conceptual and domain-specific data models. The conceptual models may include elements such as generalization, aggregation, and cardinality constraints about the objects (e.g., that a door is a kind of opening and belongs to a specific wall). The domain models deal with vocabularies defined by domain-specific ontologies, such as architecture, structural engineering, mechanical engineering, and general contractor to name a few.

This level fulfills the most important role in the filter model: adding semantically-rich information that can be interpreted correctly by different domains of knowledge. As an example, consider the design of a house. The plans produced by the architect include objects such as walls, rooms and openings. The structural engineer must interpret the plans, retrieving the meanings of the objects it contains. However, the structural engineer's interpretation is often different from the architect's: He uses different vocabularies, such as "bearing walls", "partitions", and "frames." The structural engineer may, therefore, begin his task by translating the objects from the architect's representation into his own objects, creating a totally different representation of the same floor plan. The architect will have to go through a similar process when he receives the structural engineer's drawings.

The proposed filter mechanism will automate this interpretive/translation process, using the semantics associated with each object that comprises the plans. It will interpret, add, or omit data as needed by the domain expert. For example, the structural engineer's filter will interpret architectural WALL objects as LOAD_BEARING or NON_LOAD_BEARING objects, without burdening the architect's representation of the same data. With the addition of the suggestion-based applications, which will be discussed later, the architect may be alerted when he tries to modify a wall designated LOAD_BEARING by the structural engineer, but the data describing the wall's specific load bearing properties will be hidden from him.

This process requires that some or the whole of participants share a level of ontology to be able to discuss about the same objects or concepts, as for instant the WALL of the previous example: this entities have to exist in more than one domain and they have to share part of their definition.

*Syntax level*

This level is intended to provide a common standard for exchanging data. We propose to adopt eXtensible Modeling Language (XML) as a common syntax. The main task, therefore, would be to tag each object using appropriate XML tagging. The tags alone will not carry meaning unless they are connected to ontological information that is stored in the semantic level. Given a common syntax, given the participants share a level of project-independent ontology, the access to multiple views is possible only if each of the participants defines explicitly both his internal and the external connections to the ontological information. The filter mechanism will support this design operations facilitating the participants in building their own semantic structure and "subscribing" some relations to the others.

*Communication Modes*

In terms of computer networks, there are two common models of computer networking: the client-server model and the peer-to-peer model (Barkai 2002). In a client-server model, the client (the user's computer) makes requests of the server to which it is networked. The server, typically an unattended system in a back room, responds to and acts on the requests. Data-centric approaches usually use this model. On the other hand, the idea behind the peer-to-peer model is that each 'peer,' i.e., each participating computer, can act both as a client and as a server.

The notion of decentralization is directly applicable to this model. Figure 3 shows the filter mediated communication model with published data contributed by each participant. Pure peer-to-peer computing has no central server and router, and peers in this network act as clients and servers. Hybrid peer-to-peer has a central server that keeps information on peers and responds to requests for that information. Peers are responsible for hosting the information, letting the central server know what information they want to share and for downloading its shareable resources to peers that request it.

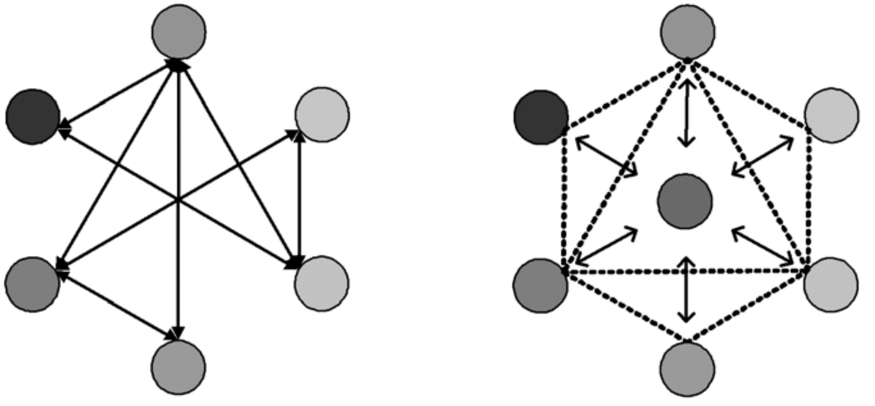

**Figure 3**
Two communication modes
pure peer-to-peer (a) and hybrid peer-to-peer (b)

The major advantage of peer-to-peer models over the client-server model is that we can reduce the size and complexity of the centralized data and even eliminate centralized control over the data, which is expected to overcome the problems of the data-centric approach discussed earlier. For practical purposes, we adopt the hybrid peer-to-peer model for filter communication. This is because in the pure peer-to-peer model, peers may spend much time and effort to find other peers and their resources. The shared data includes general information on peers, agreements on how to describe ontological specifications for the specific domains, and the latest version of each participant's published data.
We regard each participant's filter as a peer in the filter communication. When the filter obtains a connection established between the server which has the shared data, it examines the consistency of its maintained published data. First, it will publish the latest detected version of each participant's data. Second, if it detects inconsistency between the published data and the private data, it will update its published data. Since each participant's private data is dynamically changed in the course of the design, the filter will update its own published data when it is requested to provide information by other filters.
When a participant's filter connects to the server in order to retrieve the published data created by other participants, it will immediately establish a special relationship called "subscription." This will facilitate communication among filters. If the filter subscribes other published data, it will constantly check all new information on the published data so as to notify the participant and respond to the changes in an appropriate way. Although there are some changes to the published data in which the filter is interested, they may be able to be ignored if they do not affect the project significantly. For this purpose, the filter has a mechanism to specify interest criteria to determine whether the changes are relevant or not.

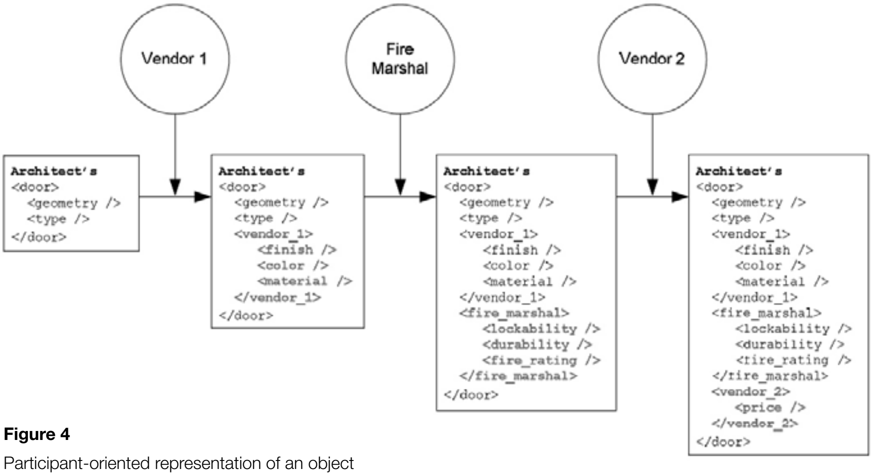


**Figure 4**

Participant-oriented representation of an object

For example, if the architect has subscribed the structural engineer's design and he is interested in the diameter of columns, he would specify an interest criterion (e.g., if the diameter exceeds 10, then notify me). Based on the criterion, the architect's filter will not notify until it violates the dependency.

This distributed communication model envisions the filter mediated communication model in two ways. First, it is an implementation of the notion that each individual's own representations comprise the entire project and they are responsible for producing their own representations. Second, when each individual's filter receives others' published data which it does not understand, it asks others' filters for ontological information connected to the published data.

## Discussion

*Participant-Oriented Representation*

Every participant creates their own objects by specifying geometric and non-geometric information as well as ontological information (or semantics). Consider that the architect designs a building with his own objects. In the schematic design phase, his objects would be generic in that they only describe the function or performance and some of the simple geometry specific to that object. It would be used to define spaces, enclosures and openings while he develops some architectural plans of the building. In the course of subsequent phases, more detailed specifications could be determined and added to the objects. For example, a door in the preliminary design phase would be used to define an entering point to analyze circulation. At this point, no specifications are needed. The color, material, finish, sound, fire-rating, and price might not be taken into account. In the design development, the architect publishes the plans and the same door object would be specified in more detail by the participating vendors. Figure 4 shows a participant-oriented representation of the architect's door incrementally enriched by the pieces of the other participant's descriptive knowledge. As shown in the case study, a structural member would be treated in the same way. In the schematic design stage, it would be modeled as a generic object. With time, the member would be more articulated and properly dimensioned with the help of the structural engineer. Once the participants contribute their knowledge to the representation, it would be possible that each of them could see the other's point of view. The dynamic and semantically-rich representation would allow the participants to make alternatives reflecting their intents more effectively, which eventually leads to a state of shared understanding.

*Distributed and Interleaved Communication*

As discussed earlier, the impact of a network-based collaborative design transforms a hierarchical/linear partitioned process into a distributed and interleaved one. where the sequence of inputs is not pre-determined, but rather opportunistic. In the filter mediated communication model, the participating professionals can affect one another bi- or multi-directionally. It means that opportunities can be recognized and acted upon in time to make the most of them, and problems can be spotted earlier, when they arise, because more specialists will have access to the evolving product: they will not have to wait their turn to be consulted, at which time it may be too late to recognize an opportunity or to avoid a problem.

Figure 5 shows that each participant has their own model which is relevant to each stage of the project, where the continuous line indicates the bidirectional relationships mediated by the filters and the dashed line illustrates their contribution to the design process. The continuous interaction among the actors and/or their filters, allows incoherent/favorable situations to be highlighted and managed in real time, and may facilitate the onset and dissemination of creative ideas.

The participants do not have to share a large and heavy integrated model. Rather, their intelligent filter will access the information in the object level (geometric/non-geometric information and ontologies) which resides at its own location and translate it into their own representation using user-defined ontologies.

They would fill the gap between the heterogeneous representations preserving semantics as long as they are based on the syntactical agreement (e.g., XML). While producing and consuming the information, the participants and their filters construct a "knowledge chain" in which subassemblies of the information are passed from one filter to another, each one contributing its own piece of knowledge.

We propose the filter mediated communication model and its process to reflect the characteristics of multidisciplinary collaborative design without sacrificing human-centered aspects, and to solve real-world collaboration problems by focusing on a semantically rich representational method at three different levels which are mediated by intelligent filters. By fulfilling the discussed tasks, the designers from different disciplines participating in an AEC project are expected to better understand the dynamic process of design, and achieve a high level of shared understanding.

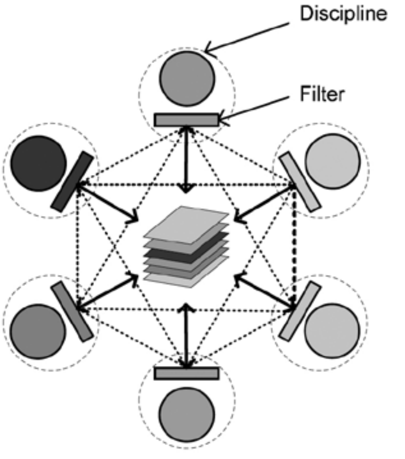


**Figure 5**

The filter mediated communication model

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Bruno Tournay

# Towards the development of a 3D digital city model as a real extension of public urban spaces

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# Towards the development of a 3D digital city model as a real extension of public urban spaces

## Electronic neighbourhood: background and objective

From 2001 to 2004 we had an opportunity to test the use of ICT in connection with an urban regeneration project in the Nørrebro Park district in Copenhagen, which was completed in late 2007.

The Nørrebro Park district is a very mixed district, both physically and socially. The regeneration project was based on extensive involvement of local residents and representatives of trade and business. A holistic approach was adopted, including a coordinated and integrated social and physical focus. The project was based on an analysis of opportunities and problems in the area and was intended to lead to contracts in which various public and private players would commit themselves to targets to be achieved and funds to be applied.

In terms of time, the ICT project[1] was limited to three years at the beginning of the district regeneration period. Consequently ICT was mainly used to establish contact between residents and to identify problems and formulate goals. The district regeneration project was geographically limited, and it whas therefore necessary to establish some kind of collective affiliation and sense of belonging to the district.

The main concept on which the ICT project was based was to set up an 'electronic neighbourhood' on the Internet[2]. The electronic neighbourhood was not intended as an alternative website but rather as an extension of the physical neighbourhood developed in parallel with the regeneration project. The electronic neighbourhood was intended as a tool that could be used in various urban regeneration projects as well as a means to gather knowledge and points of view in relation to the various activities involved. The electronic neighbourhood was thus to be a link between, on one hand, the physical neighbourhood that was being transformed and, on the other, the Internet. Just like the actual regeneration project, the development of the electronic neighbourhood was to be based on involvement of residents, and three tools were used: websites, a geographical information system (GIS) and a 3D city model.

## Electronic neighbourhood as a space of flows

Websites are of course the basis for the electronic neighbourhood, the facades of the electronic neighbourhood in cyberspace. The electronic neighbourhood is not a single website, but a network of several interlinked websites: the district regeneration website, the local newspaper website, and the websites of local housing associations and local business and trade associations[3]. It also comprises websites of a more ad hoc nature: websites created by individuals or groups of residents to discuss themes they find relevant.

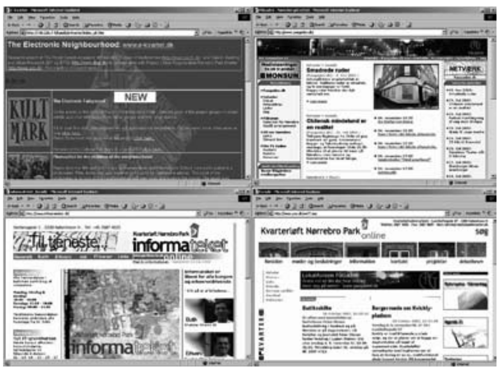
The electronic neighbourhood is thus a 'space of flows': a network of places based on telecommunications and computer systems connected around one common, simultaneous social practice.[4] The purpose of many of the projects carried out in connection with the regeneration project was to ensure physical improvement of the district. Consequently it was necessary to set up a geographical information system for the district and make a digital 3D model of it in order to be able to present discussions and proposals in the electronic neighbourhood.

**Geographical information system for the quarter**

The geographical information system (GIS) for the quarter was made on the basis of digital maps provided by the City of Copenhagen. By means of address coordinates it was possible to link central registers to maps. The GIS was thus used to map the places in the area where housing improvement and other initiatives were needed. Furthermore, the GIS was a digital centre for the storage, comparison and presentation of many types of soft and hard data in the form of theme maps on the Internet. The GIS was used to store all the pictures taken by eighty children in the area during a photo safari and display them on the Internet. The pictures were first displayed at an exhibition in the gymnasium of the local school. This actual exhibition was closed a long time ago, but can still be seen on the Internet. The tacit knowledge exposed and made easily accessible at that time has been copiously used in connection with other activities. This is also true of the Walkshop organised with wheelchair users, which resulted in analyses and proposals for improvement of accessibility in the area.

**Figure 1**

Meeting in one of the project groups in the regeneration project.




**Figur 2**

Some of the nodes in the space of flow of the electronic neighbourhood

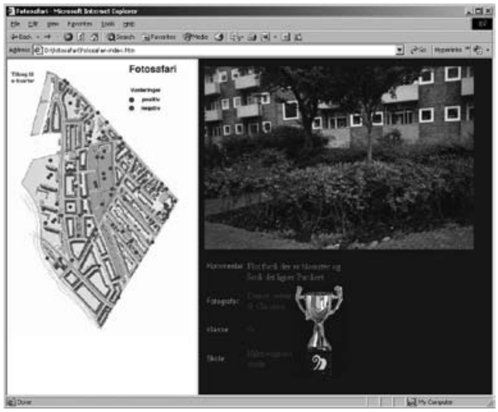



**Figure 3**
Children's photo safari: Exhibition in the school gymnasium (a: venstre) and on the Internet (b: højre).

**Figure 4**
'Walkshop' with Svend (a:venstre), and how it looked on the Internet via the GIS (b:højre)


### 3D model of the neighbourhood

A 3D model of the neighbourhood was made on the basis of the geographical information system. In the electronic neighbourhood project, a distinction was made between a base model of the neighbourhood (similar to a base map) and more detailed models that could be extended as and when needed on the basis of the base model in collaboration with the residents and the various project groups. The degree of detail of the base model is equivalent to a scale of 1:500.

The model was first used to create an identity, a sense of ownership of the area within which the regeneration activities were to take place. Second, the model was used in relation to specific activities such as upgrading of streets, courtyard conversions, etc. The development of the model and the modelling of proposals took place in collaboration with residents. In this process, the dialogue between residents on one hand and architects and urban planners on the other hand was very important, as the outcome of the project and its viability depended on this dialogue.

**The virtual marketplace**

The purpose of establishing a virtual marketplace was to have a public meeting place on the Internet where visitors could also find information about the work of various project groups. In such a virtual multi-user world (a 3D immersive multi-user world), visitors can chat in a special chat forum where they may, for example, go into projects together and have various points of view presented to them.

The virtual marketplace is based on the Cultural Fair event that takes place in late August each year. At this event, residents in the area meet over a weekend in Nørrebro Park to spend a good time together and learn more about the many activities that take place in the district.

The virtual marketplace is based on photos taken at the real Cultural Fair and is thus a 'true and faithful' reproduction of the park and the square as the residents know them. When a visitor enters the virtual marketplace, he or she will recognise the stalls, tents and stage, and will see well-known planting and buildings in the background. Each visitor is represented by an avatar, whose name and appearance can be changed at any time. At each stall, there is a board with a brief description of the group's work and possibly links to its websites. At two of the stalls - the Informatheque and the Park Group stalls – people can enter yet another virtual world or, as it was generally called, be teleported to the virtual worlds of the Informatheque and the Park Group.

The Park Group's virtual world is of course a virtual park, which is the setting of a large-scale exhibition of panels and pictures of the park in the past and present. Some of the panels are illustrated by 3D models that people can walk around in and look at. A series of historical pictures showing what the park used to look like and the life going on in it is shown on large glass panels in the virtual park.

The virtual marketplace is not an ordinary 3D model that can be accessed on the Internet. It is a 'multi-user world', which means that all the people visiting the virtual marketplace at the same time can see each other. A chat forum has been added to enable visitors to text message to ask or answer questions about the park, the regeneration project, etc or simply comment on various matters. People can thus agree when to meet in the virtual park and walk around at the virtual marketplace together with a resident of a professional guide.

On the real-life market days, the electronic neighbourhood was accommodated inside a container. By means of a microwave link, the container was connected to the Internet and thus to the virtual marketplace. Consequently it was possible, in the midst of Nørrebro Park, to take a walk in the digital representation of the park and visit the virtual exhibitions. Being in both the physical and the virtual park at the same time was quite an extraordinary experience.

There is a significant difference between looking at a picture or watching a film of a model of a project and actually walking about on one's own inside the model at a leisurely pace. There is also a significant difference between walking alone and walking alongside others and meeting others – be it anonymously or not – inside the model, communicating with each other. At some point in time it is likely that the multi-user world will become a real social space that residents will actually use as a meeting place. Thus the virtual space may become a new public urban space.

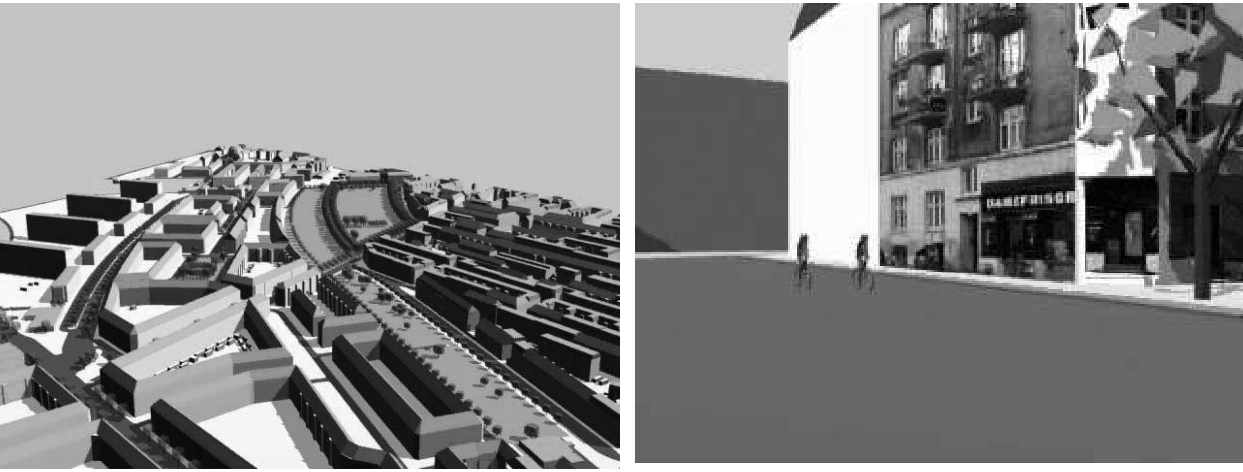


**Figure 5**
The digital base model of the district (a:venstre) and a more refined model for the upgrading of the Asminderødgade street (b:højre).

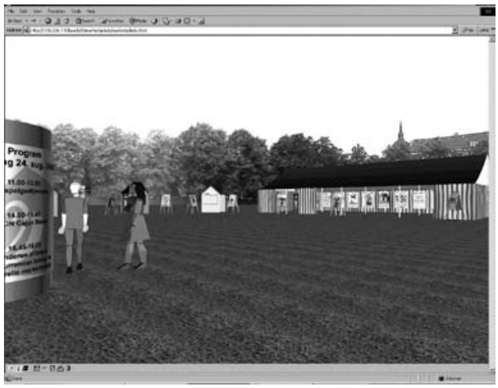


Figure 6
The marketplace at the Cultural Fair (a:venstre) and the virtual marketplace (b:højre).

**Figure 7**
At the Cultural Fair at the centre of Nørrebro Park, visitors could 'go into' the virtual market-place. Visitors (a:venstre) and their avatars at the virtual exhibition (b:højre).

Building the virtual marketplace is design work consisting of creating the model and determining its functionality. In other words, it is a specific architectural and urban planning job.

**Bits: a new building material**

The shape of the marketplace is based on the real-life marketplace in Nørrebro Park in this case, but it could just as well have been a city hall lobby with access to all the administrative departments or a front office shared by several enterprises. However, virtual worlds need not necessarily look like the buildings or urban spaces they concern.

Multi-user worlds may be created in cyberspace alone with a very clear function, eg a virtual neighbourhood centre in which individual project groups and NGOs could have specific rooms. This would give them a public face, as well as an opportunity to present their work to the public. In addition, there could be more private work and meeting areas with files for the storage of material.

This is definitely a new area for architects. In planning processes it should be considered when it would be most appropriate and expedient to cater to various needs in the physical world and when it would be best to do so by means of virtual worlds. The electronic neighbourhood project was a pilot project associated with a specific urban regeneration project, but it was not an integral part of the regeneration process, for which reason the electronic neighbourhood could only be developed to a limited extent. Consequently, the benefits for the regeneration project were limited as well.

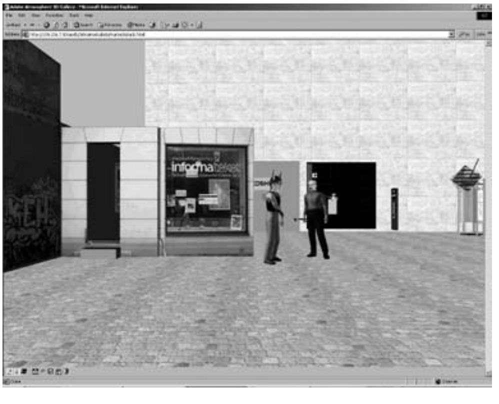


**Figure 8**

The virtual world of the Informatheque: Access via a reproduction of the physical facade of the Informatheque. Behind the authors' avatars: a lecture hall in which a slide show is running.

Architects and planners have to think both physically and digitally even in the programming phases. More than ten years ago, William J Mitchell wrote: “Architects will increasingly confront practical choices between providing for bodily presence and relying on telepresence. They will be forced to explore the proper respective roles of physically constructed hardware and symbolically encode software, and of actual space and virtual places”[5] (page 172). This is not utopia today, but an everyday issue. It challenges the general understanding of information technology and architecture, which is a conventional understanding where information technology is only seen as a tool that can be used in the design of our physical surroundings. In fact, information technology should rather be seen as a new building material that can be combined with other building materials in architectural projects[6]. Since there is only very limited awareness of this new building material, schools of architecture should explore its properties and its potential in the field of architecture.

**Notes**

1 The research project was funded by the Ministry of Housing and Urban Affairs. The research was conducted by a team composed of architects Bjarne Rüdiger and Bruno Tournay from the School of Architecture of the Royal Academy of Fine Arts in Copenhagen and architect Steen Holmgren and sociologist Kresten Storgaard of Danish Building and Urban Research. Project website: www.e-kvarter.dk.

2 At the conclusion of the e-quarter project, a report entitled “The Electronic Quarter” was published by the Danish Ministry of Social Affairs in September 2005. The report (in Danish)) can be downloaded from the ministry’s website.

3 District regeneration website: www.parkkvarter.dk. Local newspaper website: www.paagaden.dk

4 Castells, Manuel (1998): The information age: economy, society and culture. Vol I, II, III. Blackwell Publishers Ltd Oxford

5 Mitchell William j. (1995): City of Bits; space, place and the infobahn.

6 Leach Neil ed. (2002): Designing For A Digital World, Willey-Academy UK

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