Computational Design of a Theater Complex for Boston

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Bachelor of Art in Design of the Environment
University of Pennsylvania, 1997

Submitted to the Department of Architecture in partial fulfillment of the requirements for the degree of Master of Architecture at the Massachusetts Institute of Technology.

February, 2001

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Abstract

The design of a theater complex for Boston is used as a test case for the more integrated use of computers in the design process. In architecture digital media remain mostly tools for efficiency and productivity rather than design and creativity. Simultaneously computational studies have been undertaken which produce exciting diagrams or seductive forms without necessarily leading to a built or buildable work. I believe that for the computer to become a useful partner in the design process the tools must be developed - borrowed, stolen, hacked together - in a way that takes into equal consideration design thinking and computational possibilities. This thesis proposes to pursue such a middle ground by developing a design for a theater complex using the computer as a primary design tool.

The role of the theater is opened to reinterpretation in light of the continued encroachment of other forms of entertainment. The theater complex provides a place for the development of a theater culture, a space for the celebration of the attendance of any performance. Computational studies at many scales enhance the design exploration: from visualization of the urban flow to testing of acoustical and structural possibilities, from formal manipulation to analysis and conceptualization.

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The balancing act

In early September our ‘thesis group’ had a meeting – Rolando, Sean, Franco and myself with, of course, Fernando. Everyone there had already read my thesis proposal so I skimmed quickly through the contents of that and moved on to what I was working on at the time: my site analysis and my explorations of theater precedents. But they soon stopped me to ask, ok, but what is your thesis. So I went back to the beginning, explaining that I was interested in exploring ways of integrating the computer in the design process. My answers didn’t satisfy anyone: it seemed I was expected to have a more concrete answer: a specific intention about the computer. Was I going to use it for the introduction of time? for analysis? for emergent design? visualisation? CAD/CAM? What was my special, innovative angle on computation? I tried to explain that I didn’t have one, that my angle was that I didn’t want one. I wanted to develop my computational strategy based on the architectural design. And then the other questions came... what, then, was my architectural thesis? What would make my thesis more than a studio project? Again I didn’t have an answer. I had chosen to design a theater because I thought it would be a challenge, because I think they are exciting, magical spaces. Because I might have chosen a career in theater. But I also could have chosen to design something else, and I would still have had the same thesis. Still have wanted to use the computer, still have wanted to make interesting architecture.

Throughout the semester the two sides of my thesis pulled at me. Sometimes I worked on the computer, playing, exploring and not finding direct applications in my thesis. Sometimes I worked on my physical models, making and looking and not touching the keyboard. And I would get frustrated with the difficulty of trying to do both, or trying to bring these things together. I would wonder if I should have had a computational agenda. If I should have had a grand idea about theater in our society. But that would have been a lie - an answer that might have convinced anyone but not myself. Because for me the right thing was to struggle with both these explorations and to try to find ways to bring them together.

This thesis is about a balancing act, a lack of hierarchy, a need to juggle. About how architecture should stay exciting, relevant, should explore the latest technologies, but about how we still need to make architecture that responds to all the multiple layers of meaning that architecture has addressed for so many years.

And trying to do both of these things is difficult, and this thesis is only the beginning.........
Computation in the design process
Introduction

This thesis addresses the current use of the computer in architectural design and formulates an original design process. The context in which I will be developing and presenting my thesis is one of general antagonism to the use of the computer as a design tool. Many architects resist the use of the computer for anything other than presentation work. While it is easiest to dismiss their misgivings as being shortsighted and unimaginative I believe that an understanding of their perspective will help to refine the design process and ensure that the work done can be tied firmly back to an architectural setting. Fortunately, many people believe that the computer offers great potential to creative work; their ideas and processes, presented in theoretical writings and practical examples helped me formulate an initial design approach. Drawing on both a survey of the literature and test cases I began to outline my own design model.

As the technology becomes more integrated into architectural education and as more designers become proficient with these tools the computer will lose its mystique. However, unless we take positive steps to foreground design thinking the computer will never be a design tool. I believe that equal weight needs to be given to the integration of the new tools and the essential patterns of the old traditional methods of working. When previous methods of practice are replaced it is necessary to understand their essence rather then their reproducing their more superficial properties. It is essential that the model developed for design be based on the peculiarities of the designer and be well integrated into the design process. The designer must be comfortable with the tool and the processes in order to achieve a well-crafted design solution.

No consensus exists in the literature as to how to use the computer in the creative process. In fact such a consensus would inevitably be reductive for no one essential use of the computer can be defined. Rather than such a reductive view I hypothesize that the applications of the computer will only grow as we continue to realize its potential. Therefore the designer must devise methods and tools suitable to their particular design process and the peculiarities of the design itself. A flexible and open-ended design process that is led by the needs of the project and not the possibilities of the technology is important. The design should allow for inclusion of new computational tools or might need to develop such tools to reflect some need in the design. In my thesis I will integrate the computer at various stages of my process and reassess its use and the need for its existence at each of those stages.

“The computers of our imagination are also a source of inspiration - an electronic muse”

John Fraser,
An Evolutionary Architecture
Unfulfilled Potential

In my own experience I have noticed a contradiction between the general reluctance to use computers as design tools and their theoretically revolutionary potential, so far explored by only a few individuals. The literature supports the observation of this dichotomy. Thomas Kvan explains, "from the perspective of those involved...the impact of computers in practice has been very disappointing. Our research and experimentation always points to a better future than we see realized. It is frustrating to us to see the majority of practices using the tools simply as an automation of manual methods" (1995, pp.2). Kvan's observations point to a flaw in the use of the machine rather than in the tool itself. Megan Yakeley identifies a need to reassess "current notions of digital media's role in architecture as a tool for presentation, for the creation of imagery, and for the production of highly precise documentation" (1999). These authors describe a potentially extremely powerful tool that is not being sufficiently exploited.

At the other extreme it seems that the absolute and inevitable revolution of architecture is largely media hype. We read about "advances in architecture made possible by digital technology", "freedom in geometry...brought about by the extensive use of the computer", and even "new alchemic technologies" (amazon.com, 1999). In addition to being hyperbolic, these claims shroud the new technology in a mystique that prevents its absorption into traditional practice. Truly creative use of the computer is thus relegated to the realm of the avant-garde, those at the 'cutting edge'.

In an analysis of the futuristic architectural projects produced for Architectural Record's millennial issue, Kurt Anderson makes a number of interesting observations (1999). He reminds us that the application of the computer to the architectural process is still very new and as result remains somewhat self-conscious. He feels that some of the forms that are produced by architects today using these tools are largely a result of the novelty, the making 'because it is possible'. He feels confident that the real innovations will come in five to ten years time when the computer has lost its novelty value and begun to penetrate more profoundly into architectural thinking.

Stan Allen (1998a) offers an interesting analogy when describing the use of computers in contemporary architectural studios. A cat falling from the window of an apartment building located at the 3rd to 6th floor level will not survive, neither will the cat falling from above the 15th floor manage to live; yet the same animal falling from an intermediary floor will find a way to twist and relax its body sufficiently so that it will reach the ground and survive. With this story Allen implies...
that the problem with the use of the computer lies in the need to find some middle ground. A design space somewhere between the fear and clinging to the old ways that lingers in many sensibilities and the hype and excitement that are generated by and evidenced in the many publications, journals, conferences, paperless studios that have begun to crop up in recent years. In order to find this middle ground it is necessary to better understand the shortcomings of both extremes.

Computers in the Workplace

The computer has become ubiquitous in the architectural profession, both in schools of design and in practice. Yet, clearly, to cite quantitative growth tells us nothing about how or by whom the machines are being used and how successful or creative that use is. Penzias (qtd. in McCullough, 1996) claims that the majority of people who use computers are not even computer literate. More qualitative information is difficult to gauge and necessitates very specific surveys. I have accessed three sources to try to gain a fairly complete picture: the AIA firm surveys (1987, 1989, 1997), a study by Kalisperis and Groninger (1994) and research conducted by Kvan (1995).

The AIA survey is the broadest in its range of cover, but addresses fewest specific questions about computation. The limited relevance of the AIA survey led to the research by Kalisperis and Groninger (1994) who were interested in gauging the use of computers in the design process. Their study is of much greater relevance to my research as it examines why computational aids in architecture have resulted in only a marginal improvement in architectural design practice. One of the drawbacks of this study is its much smaller respondent base. Examining it in conjunction with the wider ranging AIA survey allows confirmation of the results. The third survey accessed is one conducted by Kvan (1995) and focuses on practices in Asia. He uses a similar model to that of Kalisperis and Groninger.

The research confirms the widespread use of computers in architectural practice, with 90% of firms using the machines in some capacity. Kvan finds a similarly high proportion of CAD use in architectural offices in Asia. More important, however, is to assess how the computer is being used in these practices.

One such qualitative indicator is the software that is being operated by the firms. The most common uses are word processing, spreadsheets and specification writing software. CAD programs are the fourth most utilized software. There are also packages used for financial management, marketing and then some small number of firms using analytic tools such as those for energy or structural analysis. Clearly many of these software packages address the running
of a business and are not related to the design side of the practice in any way. Although it may be true, as Kalisperis and Groninger suggest, that design firms have made use of these utilitarian packages to enable them to free up more time for design this indirect utility of the computer to designers is not directly relevant to my research.

All three of the surveys found AutoCAD to be the dominant software package used by architects. The numbers vary from 42.7% AutoCAD use according to the Kalisperis and Groninger’s survey to Kvan’s finding of a full 90% of Hong Kong practices utilizing AutoCAD. This fact becomes most interesting when viewed relative to other findings. Kalisperis and Groninger cross reference the findings for CAD package used with other information from the survey relating to firm size, satisfaction with software and categorization of firm as design vs. pragmatic. In this way their study reveals some interesting new information. Although AutoCAD was most widely used it was the package that had the lowest user satisfaction rate. Also, although AutoCAD was the software of choice for the majority of firms overall it was used only by approximately one third of those firms that identified themselves as ‘design/theory firms’ compared with about 60% of ‘pragmatic firms’. Also of those pragmatic firms utilizing AutoCAD there was a reasonably high degree of user satisfaction while design firms found this software to be far less satisfactory. The conclusion is drawn that this program is best used for drafting and construction documentation while other packages are better suited to the design use of CAD. Kvan’s finding of such a high percentage use of AutoCAD might be a result of a similar situation as he finds that most Hong Kong firms classify themselves as management/pragmatic based rather than design based.

Kalisperis, and Groninger further find that it is necessary for the software to be improved to make it more useful in the design process. However in this regard it is interesting to note that they also find that those firms independently surveyed because of their design excellence showed a far higher proportion of satisfaction with the software than in other firms. The survey also found that in addition to the 2D components of the packages used by almost all firms surveyed the design/theory firms were significantly more likely to use 3D and solid modeling techniques than were other firms. This suggests that at least some of the burden of improved use of the computer lies with the architect and not with the software designer. There are clearly capabilities of these CAD programs that are not being fully utilized – those firms that are using AutoCAD for two dimensional drafting only are forfeiting a large proportion of the programs capabilities. This is partly, as Kvan (1994) points out, a result of insufficient emphasis in architectural education on

“Ideas are often born unexpectedly--from complexity, contradiction, and, more than anything else, perspective.” Negroponte, Nicholas in Wired. January, 1996.
learning the use of more complex solid modeling and 3D tools.

One of the most useful categories in the AIA survey was that which links use of CAD with education and status in the firm. In firms of over 5 employees the breakdown of CAD use shows that 60% of CAD operators are non-architects. In smaller firms the ratio is about 50/50. Kvan's survey confirms that the majority of designers, the principals, managers and architects are not the CAD users. Respondents showed that many CAD systems were in fact being managed by interns, who had little input or knowledge of the design philosophy of the firm, or even of architecture more generally. This is a good indicator that much of the work being done on the computer is not design oriented.

Another important analysis breaks down CAD usage into types of drawings produced. In assessing the types of drawings done on CAD the AIA firm survey finds that on average 12% use the computer for conceptual design and 24% for construction drawing— if the figures are considered only for firms who use CAD software the statistics are 28% and 55% respectively. Unfortunately the survey is rather cursory in its delineation of what it means to utilize the computer in the conceptual design phase and it is certain that much of the reported usage is for documentation of the conceptual design phase of the project rather than direct CAD development of the design.

Surprisingly, Kvan similarly finds that a much higher degree of firms surveyed use CAD in the conceptual/schematic phase then expected. Further his survey found that more firms were placing computers on the desks of designers and draftspeople in an attempt to facilitate better incorporation of the computer as a design tool. In fact Kvan’s survey included a question asking for ways in which use of the computer could be improved and the finding here was that most respondents understood the necessity for CAD users to understand architectural design better, for designers and not CAD operators be employed to use CAD software. He noted that there had been a move to realize this change in architectural practices in Asia.

Changes are already occurring in the use of computers in practice and these will naturally continue. As computers become a routine part of architectural education all designers will have at least some power of control over this tool, closing the divide between those who use the computer and those who do the designing in many architecture firms. Improvements in the software will also address a number of the current limitations. However, to really achieve the potential of this tool a truly different way of thinking about computers in design needs to become part of architectural
Thinking about computers as a way to design

Malcolm McCullough believes that some of the increase in CAD use might actually be detrimental to the improved use of computers in design. He claims that in attempting to get the computer to quickly and efficiently automate existing tasks there is a way of thinking that is constructed which is not only unhelpful but which might even act as a barrier to finding new creative ways of using the computer. “Most people would just as soon know no more about computers than whatever it takes to get some work done. But what is important to know... The only way to make sense of the endless techniques is to address them with some higher conceptual framework, but this is just what the circumstances of training so often fail to do. Some huge majority of computer cooperation occurs without much notion of abstractions, but only as trained sequences of actions. This condition is understandable given the pressures of getting business done, but it is hardly the best approach even for that” (McCullough, 1996, pp.113).

Kvan confirms the importance of knowledge, though without explaining precisely what this knowledge should be. “We all know, however, that we can squeeze a little more out of their machine if we understand the parameters of its operation, although perhaps not the details” (Kvan, 1999a). When Kvan writes about the ‘parameters of its operation’ it is unclear what these parameters are – and his lack of clarity on this issue is perhaps a reflection on the fact that there are multiple definitions of this concept in the literature. His elaboration “not the details” suggests that it is not in some specific scientific or mechanical understanding of the computer that the designer will find inspiration, but instead in a more personal reading. In a similar manner, Allen urges us to look for the “paradigms and protocols at work in the use of the computer as a design tool” so that we can “become familiar enough with the technology so as to be able to strip away its mythological veneer” (Allen, 1998a) – to examine the computer as a tool with specific constraints and capabilities and by doing so to make it more real and thus more powerful.

Searching for the essence

What are the paradigms, protocols, boundaries, and characteristics of the computer? That depends on who is being asked, for it appears that the essential quality of the computer can be identified and defined in many different ways. It is important to explore the meaning of ‘paradigms and protocols’ as it relates to the computer and to deconstruct the concept of computer as tool.

The computer is well suited to registering small changes, and to cumulating these incrementally
The ability to use reiteration and recursion is a powerful one and can be employed in many varied ways. For Greg Lynn (1998a) it is most useful in that it gives the user the opportunity to participate in a complex space of dynamic flows based on calculus rather than the simplified static space of algebra that has been the one where architects previously operated. Calculus is, by definition, a mathematics of incremental small calculations which when combined gives a simulation of continuity and the computer is thus by definition suited to tasks based on calculus. Lynn believes that architects have to re-educate themselves now that, armed with this new technology, they can re-integrate time and motion into their designs, both of which he believes they had been trained to studiously ignore.

This processing power leads Allen to define the usefulness of the computer in this way, “the power of the computer lies in its ability to handle large amounts of information, multiple variables, and abstract codes - it is worthwhile to be attentive to an emerging sensibility for diagrammatic and loose organizational paradigms, a contingent, “conditional abstraction” (1998a, p. 76). The capacity for processing bulk information quickly, and without passing judgment has already been utilized for the development of diagramming and organizational models. Van Berkel and Bos (1996, p. 58) claim that their way of working from the diagrammatic to the architectural, a system that has always been part of their practice, enables them to take advantage of this quality in the computer.

While this ability to work with enormous data sets and to register multiple small informational responses can be used positively, McCullough sees a flip side to this capacity. He claims “computers fragment our thinking by substituting discrete events for continuous actions...[and] tempt us to produce prolifically rather then to refine our work” (1996, p.28). According to his concept of the digital craftsman, the ability to overcome this temptation – to turn it to one’s advantage – lies in the state of mind of the user, the skill that he brings to his task. The acknowledgement of Van Berkel and Bos, that it was their way of thinking about architecture as diagram which allowed them to utilize the computer, is also a confirmation that the mind set of the designer must be synchronized with the capacity of the tool.

Another of the defining features of the computer is that its output has a level of specificity and finality, which a sketch does not have – a sketch is not a symbol that can be read with surety. As Kvan points out, this can be limiting in the initial phases of design especially, where, “much of the
Talia Braude

perceived freedom ... stems from ambiguity or the ability of each perceiver to interpret results in their own way" (1994, p.4). At a final review for the 'digitally mediated design' workshop at MIT this comparison between the traditional sketch and the computer-derived 'sketch' came under consideration. Yakeley's assessment was in agreement with the ideas of Kvan as she stated that the output of the machine did indeed appear dauntingly concrete and final. However, she suggested that in utilizing algorithms to achieve this output the designer was able to see multiple versions of the same code made concrete in a matter of moments. It is in the possibility of producing numerous examples of any one output that the opportunity for ambiguity arises. It is the collection or set of these examples that together make up the sketch. Yakeley believes that as a series of possible outputs flash across the screen the designer is reflecting on them and building a picture from the parts that contains some concepts from all. Here traditional notions of the architectural design process are reinterpreted based on the specifics of computation rather than trying to force the computer to give us a diluted version of what can be done better manually.

Another way of defining the difference in traditional vs. digital media is in classifying the basic building blocks of each, the one made up of atoms, the other of bits. The computer therefore allows the designer to define space without needing to refer to or obey the laws of nature or science. Muschamp (1999) sees the new technology as allowing the designer to draw on a lineage of surrealist thinking to enter the realm of fantasy and intuition. "Computer technology shifts interaction between inside and outside to a new plane." Is the computer – ironically given its own intrinsically binary nature – going to be responsible for a break from the "binary inside-outside structure" (Muschamp, 1999)? What will it mean to design these surreal structures? Will we, perhaps with the help of the computer, ever be able to build them?

A Broader Definition

The overwhelming impression that remains after reading these various definitions, and the corresponding conceptualization of how the computer should be used, is that there is no consensus in the literature. While it is interesting to examine these specific applications and conceptualizations of the use of the computer, it is equally interesting to remove oneself from this discussion to contemplate what it means for this machine to be defined in so many ways. What kind of machine is this relative to other implements that designers have used?

The word tool is used frequently in the discussion of the computer, yet it is not unproblematic. Much of this difficulty stems from the general conception that a tool is something that is held in
the hand, that relates to the body, which is an extension of our own self. Brenda Laurel (1991) thinks the use of the word tool in reference to the computer is incorrect, for it implies that we are operating in a concrete and real world rather than on a virtual, representation. However according to McCullough the tool is a piece of technology, of intelligence that can extend the power of the user, and can engage him, engage his imagination. In his view the computer and the book are tools in that they do extend the power of the user, not the power of his hand but that of his mind. Yet beyond this he also vests the tool with a metaphysical meaning that is above that which it does, “the oar is not only for plying through water, it is about plying through water.” He advises that knowing and clarifying the symbolic nature of the work can give meaning to the work.

Later in his text, though, McCullough gives a new definition to the computer, as a medium instead of as a tool. “Often the key to working more satisfactorily is to understand the computer as medium” (1996a, p.61). And with this new definition Laurel, in her advice for the interface designer, concurs - we should “Think of the computer not as a tool but as a medium” (Laurel, 1991, p.15). The use of the term medium implies some sort of middle ground, something upon which the tool acts to produce its effect, as a painter operates in paint, a sculptor in wood. For McCullough the medium is more important than the tool - it is this that we should be focused on. The tool should become so much a part of us that it almost disappears; the attention should be on the resulting work. He defines the medium as the realm of possibilities for a set of tools. If even McCullough, who in his book expends much energy on this definition, contradicts himself as to whether the computer is tool or medium and why, then this is surely indicative of the difficulty of making this singular definition.

Indeed, the use of the terms tool and medium are singular, constrictive. The computer, unlike paint, fabric, timber, proves incredibly difficult to define in one overarching way. It is perhaps more helpful not to try to do this. Kay admits, “the protean nature of the computer is such that it can act like a machine or like a language to be shaped and exploited. It is a medium that can dynamically simulate the details of any other medium, including media that cannot exist physically. It is not a tool, although it can act as many tools. It is the first metamedium and as such it has degrees of freedom for representation and expression never before encountered and as yet barely investigated” (qtd. in Laurel, 1991). Can we define this metamedium further? Perhaps it is this that Laurel refers to as the “refined mental model of an abstract world that is operated on through the computer. This abstract model is the object of action and the computer is only the framework”

Computation in the design process: a broader definition
Can we identify and explore what this refined mental model, this abstraction, is about?

Some authors suggest that it is useful to find a theory of computation that does not address the computer as a machine, but rather the kind of thinking, the philosophy, upon which it is based. Mitchell in his preface to The Logic of Architecture explains what he sees as the importance behind such a theory. He claims that "the theoretical presuppositions underlying computer-aided architectural design systems are rarely made explicit – and when they are, they often turn out to be shaky and inconsistent. There is an urgent need for a comprehensive, rigorously developed computational theory of design that can provide an adequate basis for practical software development work." (1990, p.x) This computational theory is based in studies from diverse fields: linguistics, artificial intelligence, and cognitive science. Steven Holtzman (1994) in his Digital Mantras, another book that aims to provide a theoretical background for the creative use of computers, also draws on the fields of music, art and mysticism. What Holtzman points out is that these ideas can be usefully applied outside of their respective fields and form much of the theory behind ideas of symbol manipulation upon which a theory of computation is based.

Moving away from specific notions about computers to more general theories of computation reaches toward something less tangible and hard to define. Greg Lynn hints at this when he talks about "negotiating the degree of discipline and wildness, [to] cultivate an intuition into the behavior of computer-aided design systems and the mathematics behind them" (1998a, p.19). It is this word 'intuition' that is most interesting here. Kvan, expanding on his frustration at the way that computers have failed to live up to their promise in architectural practice, expresses a similar idea: "the problems can be traced more often to the implementation strategies and philosophies of practice rather than technical problems" (1995, p.3). The locus for redefining the use of the computer thus seems to reside at the boundary between the user and the computer. Indeed, Kvan gives the user much power when he claims, "You can squeeze what you want, efficiency or creativity. If an architect thinks only of efficiency, they will only be able to squeeze efficiency out of the system. If they think of creativity, they will be able to get that out" (1999b). This is important confirmation that the power of the computer rests in the hands of the designer and is dependent on the way of thinking and the intent that the designer has.

The importance of the user in this way of looking at the use of computers is in opposition to a model of artificial intelligence in which the computer is capable of learning to design on its own.
Indeed McCullough stresses that a 'partnership' is necessary, he does not think that the best use of the computer is in allowing the machine to simulate intelligence but rather in finding a way where the strength of machine and those of man are integrated – partnered.8

The idea that the creative user will find a creative tool in the computer while the person seeking only efficiency will find no more than that, is one that underlies much of the writing in Brenda Laurel's Computers As Theatre. Laurel's (1991) suggestions concern conceptual changes to the field that she believes will have an enormous impact and are based on re-envisioning the human computer interface according to a theatrical model, which will provide for greater involvement and action by the user, a greater flow of themes and stories in the use of the machine. In his preface to this work, Donald Norman (qtd in Laurel, 1991) states that implementing Laurel's changes in the way computers are seen and designed for, can provide new opportunities for creativity and interaction. According to Norman what is even more important than the specifics of Laurel's scheme is the fact that in this model the control of the technology is given to the creative individual, to people who understand human interaction, and taken away from the engineers. Unfortunately, though the software designer might be a better person in whom to vest control of a machine for creative use than the engineer, they are nevertheless a third party to the creative use of their software. Given that this control is important it seems clear that the power needs to be given directly to the user, in this case the architect, and that the responsibility for this lies with the user himself.

There are several ways that the designer can take control of the software - by using macros, programming, learning to hack together different software programs to give the necessary combinations, achieving “personal mastery of open-ended software” (McCullough, 1996, p.21) over use of deterministic software. Further, there is the possibility of changing our way of working within some given software. For example McCullough points out that the software is incapable of working at a speed and with a fluidity that is commensurate with our thinking processes as we design. There are innumerable little pauses that occur as we wait for things to process, to save, to change, to register and as a result we are often in a situation where we are focusing on issues that should be fading away into the background. Certainly the absence of this flow when we work with the computer makes it difficult to become totally absorbed in the process, difficult for the tool to become transparent. McCullough is keen to remind us though that any craftsman must be aware that all tools, all mediums have their inherent strengths and weaknesses and that the ability to work computation in the design process: a broader definition
around the shortcomings of the medium is important and the ability to turn these weaknesses and limitations into strengths is what identifies a skilled worker. McCullough gives specific suggestions for making the transition from computer user to computer craftsperson. One could, for example, slow down the rate of working to match that of the machine so that there is a synthesis in the workings of the partnership—rather then working at top speed and then finding that there is a need to wait while the machine catches up. This will facilitate an absorption in the work that is one of the most important qualities that allow it to be linked to the idea of craft. Again McCullough reminds us that this need to listen to the material is not new to our digital craft. The skilled craftsman always knew not to push the material till it broke but rather to carefully acknowledge its limitations and work with them, carefully and respectfully. The unskilled craftsperson will break the wood as he whittles and bends it, the skilled worker, understanding the nature of the wood, the strength and speed both possible and necessary will not make the same mistake. Our knowledge needs to be of what the tool cannot do as well as when it can, both positive and negative knowledge can frame a complete and useful understanding of the tool.

The wide range of attitudes toward the computer that are held even by this relatively narrow field of writers is proof that the computer is too complex a machine to be easily reduced to some simple essence. There are, however, certain ideas that are common to many of these authors and which we can use as a basis for the pursuit of design using the computer. The computer will be only what we allow it to be. It is a very powerful machine but nevertheless not a magical one. It relies on input and guidance from the user. By embracing and enhancing rather than denying the control that we have of the machine we can begin to make the computer a truly interesting tool. We need to actively pursue a way of thinking about the computer that is constructive and rid ourselves of the old ways of thinking about the computer as a machine for automating and making more efficient the old tasks. Only by thinking about the computer in new ways will we find new ways to make it work.

Design Thinking Applied to Computation

In searching for new ways to think about the computer it is not necessary to invent a new way of looking at design. Indeed, for the designer to take control of the tool and develop the kinds of philosophies, intuitions and intentions that are necessary he must incorporate those design ideas that are part of his working method. While this kind of knowing is difficult to define and therefore hard to actively pursue, it is not something new to architecture. Donald Schon (1983)\(^9\) has done
extensive research in this field and proposes looking for an 'epistemology of practice implicit in the artistic, intuitive processes which some practitioners do bring to situations of uncertainty, instability, uniqueness and value conflict' (1983, p.45). It is possible to extrapolate from his research and to incorporate these ideas into a model that depends on the computer as a design tool.

In Schon's opinion, the fact that architecture faces "new techniques of information processing in design" (1983, p.20) makes it more important than ever that the architect is capable of a high level of fluidity, adaptability and flexibility in his approach to design. However, this is not some new way of working that results because of new techniques or new tools, rather it is the way of working that has always served architecture best, but which is so difficult to articulate. Since the designer is not looking for a pre-formulated answer, but rather a personal one, it is necessary to find a way of "making sense of uncertainty, performing artistically, setting problems and choosing among competing professional paradigms when these processes seem mysterious in the light of the prevailing model of professional knowledge" (1983, p.20). What is important in Schon's writing is not only that there is a knowing that occurs without our awareness, but also that we can, with practice become increasingly reflexive upon this process.

One important question to ask is, where does this knowledge, the knowledge of the skilled craftsman, of the reflexive practitioner, reside? It is not so much a mental knowing as the knowledge held and maintained in the body, contained in the hands, a 'knowing in doing'. It is the same knowing that McCullough is addressing as he looks for a way to reunite the hand/eye/tool/mind so that all of these can contribute to the knowledge, so that the use of the computer can become a craft, a digital craft. McCullough, like Schon, believes that it is possible for the designer to actively pursue this state of mind.

Although many of Schon's ideas about reflective practice and craft, about knowing in doing, are applicable to computer users and much of this thinking is echoed in McCullough's writing, there is an important distinction that has come about as a result of the use of computation. For McCullough it is important that as we redefine our use of the computer to include notions of craft we not forget its power as a symbol manipulation device. While he discusses the difficulty of bringing these two concepts together, McCullough clearly believes that this synthesis is necessary. For centuries the tool user and the symbol user were identified as very different people, there was generally a hierarchical difference too. The computer is both a tool and a symbol-manipulating device and as such it provides the opportunity to find a middle ground between tool use and symbol use. It is computationally in the design process: design thinking applied to computation.
the process of humanizing of symbol processing that McCullough (1996) refers to as abstracting craft. Similarly the continuous medium that had no notation, and symbolic notations that had no continuous media can now be brought together with a continuous symbolic notational medium that has no material."  

By starting with an understanding of design thinking and then introducing computation we ensure that the emphasis remains on the architectural process and not the technology. The computer is made to serve as a tool to the design rather than the reverse. The complex relation between the product and the tool of its design ensures that the introduction of new technologies to the design process will have profound results.

Conclusions

My initial observation of the divide between those who were interested and excited about researching the new technology as a creative tool and those who were prepared to accept it only as an instrument for increased productivity has been substantiated throughout the research. Increased familiarity with the tools will naturally lead to a demystification of their capabilities. However architects need to play an active role in order to further the transition of the computer into a design tool. I believe that it is necessary to integrate computation into the traditional process rather than attempting to recreate architectural practice – taking into considerations the reasons, the essences behind traditional ways of working. Every designer, and every project, will necessitate an individual approach to the integration of computation and design.

The idea of the partnership between the computer and the user that is mentioned in the literature can be actively fostered. The ability to feedback our observations into the computer model should be pushed further and can be integrated into software when it is designed or added by the user in the form of coding. We need to find ways to output our work frequently such that we can examine what has been achieved and build upon it. There are emerging methods for producing physical models from the virtual that should be integrated into the design process. The computer challenges our understanding of what a tool can be, for its power lies in the fact that it can be utilized in many varied ways. The lack of consensus in the literature about its use is indicative of the fact that it is impossible and undesirable to reduce the power of the computer to some simplistic formula. It is therefore desirable that the designer integrates the computer into the process in a way that remains flexible and responsive to the changing needs of the design.
Notes

1. The literature survey included examinations of theoretical writings of many architects exploring ideas of computation. Particularly helpful were McCullough's Abstracting Craft and Mitchell's The Logic of Architecture.

2. The book reviews from which these quotes were taken are from the website for Amazon Books. This source provides a measure of the absolute extreme of media sell for the digital revolution.

3. Literacy is named as being the number one fallacy of computer use.

4. The AIA firm survey, conducted every two to three years, is a general survey of architectural firms including measures of organization, size, fees, salaries, etc. This fairly comprehensive survey includes a large number of firms but it addresses the use of computers in a limited way with only a short section on 'Computers and CAD'. The survey includes a mere four pages of results and conclusions in this area and they are extremely qualitative in nature giving little feeling for the quality of design work that the computer engenders. The regular interval at which this survey is conducted allows for useful comparisons over time. The exponential growth in the field of computation points to the need for extremely current data to be used when drawing conclusions in this area. Even the latest AIA survey, from 1997, is already outdated.

5. In an attempt to address the question of design more thoroughly Kalisperis and Groninger ask each firm to identify themselves as fitting into one of three groups with respect to design philosophy - 'design/theory firms', 'mid-range firms' and 'pragmatic firms'. The authors acknowledge the difficulties in assessing the use of computers in design, not least of these the need to define the term design itself. They realize that in basing their assessment on this limited, quantitative and self-administered test of design capacity they are greatly simplifying a very complex process. Nevertheless the survey generates several interesting results when these findings are cross-referenced with other statistics. In addition there is a separate survey undertaken among firms noted for 'design excellence' to examine whether statistics differed significantly among this group.

6. The class is intended to "focus on the role of digital media in design, and...challenge current notions of digital media's role in architecture...[through] the algorithmic approach to three dimensional synthesis" as well as "to develop more appropriate models of computer mediated design". (Yakeley, 1999)

7. Chapter 3, entitled simply 'Tools' p.59 – 82, gives an in depth discussion on this subject.

8. Both Laurel and McCullough use this word in discussing the computer-human dynamic.

9. Schon studies the nature of design knowledge. Though he does not address specifics of tools used and processes undertaken, he analyzes the manner in which these are conceptualized and realized as part of the working process. His research covers not only architecture or even the design professions but 6 varied professional constructs all of which utilize to differing degrees the kind of thought processes that he is addressing.

10. There is an echo here of the distinction which has traditionally been made between research and practice, between basic science, applied science and finally the practical. As with the hierarchical distinction between symbol manipulator as superior to tool user, so too basic science is seen as more pure than applied science or practice. As Schon points out - in this hierarchy, based on the superiority of pure science, there is simply no place for craft or art, which are seen as lacking in rigor and science. But he goes on to note that there has been a rebirth of interest in the topics of 'craft, artistry, myth'. McCullough's book, with its title Abstracting Craft, pays testament to this rebirth and also goes along way to explain what McCullough sees as the reason for this reawakened interest.

11. Chapter 7 'Medium' gives a detailed explanation of these ideas.
thinking about theaters
Introduction

The design of a theater is no simple task – theaters are among the most complex of building types, including vast areas of support space and complex technological requirements. The large spans needed to provide unobstructed views necessitate structural innovations. How does technology impact on the design and construction of such a space? Over and above these complex questions of organization and construction, the creation of a place appropriate to house theatrical events is challenging and exciting undertaking. The theater designer faces many questions about the role of theater today. Does the introduction of increasingly complex technologies negate the important live communication between performer and audience? How do we allow for future changes in this media? These questions are vital to the creation of a theater space that is contemporary and realistic. Yet the purpose of this thesis is not to redefine the role of theater or suggest any global solution for dramatic venues. Rather I intend to acknowledge the existence of these complexities in this field and create a space that is flexible enough to incorporate changes in the media, reinterpretations of the genre and experimentation by performers and audience alike.

In addition the designer must address the fact that contemporary theater has become an elitist and exclusionary pursuit that differentiates itself by its attitude from the offerings of street performers and the creations of theme parks. How can the contemporary theater become more inclusive yet retain the magic of the ‘event’. How, and how much, should we mark the boundary between the theater and the outside world, how can the entrance, the lobby, the public spaces be designed with these questions in mind.

A Theater in the Information Age?

Inevitably for anyone designing a theater today one of the first questions that arises is whether there is even a place for theater today. Whether it has not been usurped first by traditional media such as film and television and more recently by information technologies. And if the theater survives what role does it play? How does it address other entertainment forms – is it a loftier typology or a dated, inferior form?

For some people the answers to these questions are clear – the creative artist should work at the cutting edge of their field and in this case that rules out theater. To continue to pursue a career in theater is an anachronistic undertaking. “Why would you make live work in an age of mass communications? Why work in more or less the only field which still insists on presence? For artists interested in “the contemporary” this area of live performance seems like a bit of a thinking about theaters: introduction
backwater. Do you work from some quaint notion about immediacy and real presence?"\(^1\)

To dismiss theater this easily would be unfortunate. There are still many people who are strongly supportive of this media and as Carlson notes “the theater is in fact one of the most persistent architectural objects in the history of western culture."\(^2\) Having adapted itself to so many cultural and historical situations it is hard to believe that there is no way to adapt the theater for contemporary society. While the initial response to new technologies is often to attempt to completely replace the older systems, in many instances there is not this kind of linear progress\(^3\).

While I believe that there is possibility for the inclusion of theater in the future of entertainment I realize that it would be foolish nostalgia to believe that the theater should not be re-examined in the light of recent technological improvements. The first step I have undertaken in this re-examination consists in trying to understand what it is that sets theater apart from other media, and what they share.

Part of the wonder of going to the theater is the creation of a ritual, a magical and spectacular event. Going to the theater is not merely sitting down and watching a show instead the entire evening, with the sense of arrival, the procession to the seats, the curtain rising, the intervals, the end, the applause, all are all part of the act of going to the theater. In Baroque times going to the theater had little indeed to do with watching the performance, documentation from that period shows that the audience was frequently more interested in perusing one another’s fashion finery, gossiping and eating than in the narration of the play.\(^4\) In Shakespearean England the crowds who attended performances spent the hours waiting to be admitted engaged in similarly noisy, if less ostentatious pursuits, and the crowd did not become more subdued once the performance had begun, indeed they not only talked and ate but also frequently participated in the act by throwing food at the cast and other such exercises!

The creation of an event of this magnitude is not inherent in, nor particular to, the dramatic form: in the early days of cinema there was equal splendor to be had when going to see a movie – the Wang theater in Boston staged evenings which included the cartoon, newsreel and main film, live music, food and even dancing in the lower hall. Yet all this glitter has since been stripped from our cinemas housed as they are in huge and impersonal multiplexes. Theaters retain something of this quality – although they too have lost much of the excesses of earlier times.

Another advantage of going to the theater is the possibility of becoming part of a group, the collective “audience”. There is the feeling that one experiences emotions that are at once
highly personal and simultaneously shared with the actors and the other spectators. Once again, on closer examination it does not seem that this quality is unique to the theatrical event. Groups get together to watch non-live entertainment and become transformed into an audience by their participation. Auslander, in arguing that the idea of the creation of community is not distinct to live entertainment, cites many opposing examples, including the amazing sense of camaraderie generated at the televised broadcast of the Olympic games\(^5\).

A third important element given as a defining part of theater is the ‘authenticity’ of the experience, the ability for the actor and the spectator to confront each other directly and immediately. One of the main advantages of theater over film and television is that the actor is able to adjust his performance to the responses of his audience making the theatrical event entirely unique at each performance and giving the spectator an active and important role. In this regard it is seen that theater is dependant on “expressive capacities of the human body” – and that there is a corresponding necessity to address the scale of the human including acoustically, the voice range and visually, the ability for the audience to clearly read the emotional displays of the actors. For Hall this is the real advantage of theater, since the “sense of immediacy, of ‘being there’ after all, that is why we seek out theaters”\(^6\).

However, today’s technologies are capable of providing live, continuous, two-way broadcasting between actors and audience so that they can achieve a high level of feedback between the two. Mitchell believes that the time is not far when these networks will completely replace conventional theater. “Carried to their logical conclusion, these reconfigurations and transformations completely rip apart the traditional architectural relationship between stage and auditorium, performers and audience. The great house of the theater condenses into an electronic box with a screen and a video camera. When you want to be a spectator, the bezel of the screen becomes your proscenium – framer of the action. When you want to become an actor, the camera provides access to an audience and the entire network is potentially your auditorium.”\(^7\) Nevertheless for now at least there is no technology sophisticated enough to reproduce and convey digitally the nuances of non-verbal communication that can be picked up by two people in the same space.

These are the most often cited factors that differentiate theater. Auslander dismisses all the above arguments as “clichés and mystifications” used to explain the value of live performance and sees these as creating a “reductive, binary opposition of the live and the mediatized”\(^8\). The
arguments are certainly difficult to quantify and therefore remain loose and vague. Nevertheless he realizes that there is something about attending a live event which is impossible to achieve with other forms. He refers to the cultural value of live performance – the cachet of being able to say, I saw the Beatles live in concert! Unfortunately, even this value is being eroded, as mediatized versions of performance gain symbolic value, so that someone who owns a bootleg copy of some obscure Beatles performance gains significant prestige for this also.

As an architectural designer it is impossible to forget the important fact that theater is a located and locational event. Indeed according to McAuley it is the theater’s spatiality that is of paramount importance. The simultaneous occupation of a space by audience and actor differentiate theater from other dramatic media. In explaining this conviction McAuley goes back to the basic meaning of the terms theater and the most fundamental definitions of drama. The word theater means both the place and the act/ the art. By using one word to describe the two there is a fundamental linkage of the act with the place in which it occurs. Further she says any definition consists at its most basic of the relation between the actor and spectator and the space in which they interact. Claiming that, “Theater is two planks and passion” Athanasopoulos references this same basic structure. Successful theater design is a balance between the “practical planks – denoting physical location in space - with the spiritual passion”

9. In addition the place of the theater becomes even more important given the fleeting nature of the theatrical event and the inability to note, replicate it.

I believe that all of these characteristics do add up to give theater a special quality that none of our other entertainment forms can replace. Yet perhaps this is a defensive position and not an objective view of our culture, as Auslander points out: "This situation has created an understandable anxiety for those who value live performance, and this anxiety may be at the root of their need to say that live performance has a worth that both transcends and resists market value."10 Yet despite his clear conviction that traditional theater is untenable in our culture, Auslander does not believe that this means we should completely forsake any attempts at making theater spaces. Rather he claims that what we need to do is reassess the terms under which theater is understood. "The resulting assessment of the situation of live performance in a culture dominated by mass media has not made me optimistic about the current and future cultural prestige, as understood in traditional terms. It has also enabled me to see however, that those

“All the world's a stage,
And all the men and women merely players.”
William Shakespeare (1564 - 1616),
“As You Like It”, Act 1 scene 7
terms may no longer be the most useful ones". What is needed he suggests is an expansive and complex definition of entertainment that allows for both the 'live' and the 'mediatized'.

Technology in the theater

Although we make a distinction between live performances and other forms of entertainment, today's theaters are far from being an unmediated environment. Theaters use acoustic and visual enhancements in many ways, from the small microphones used by individual actors to the complex sound systems that amplify and resample their voices; from the screens on which performances can be projected for viewing by latecomers and overflow audiences to the translation texts for foreign language productions that are displayed above the performance space. There are those who argue that even the most humble uses of technology are contradictory to the spirit of theater - that an auditorium should be no bigger than the space in which an actor can make his voice heard and have no more spectators than can easily view the performance. However this view is naïve and it also imputes to all theater before our contemporary creations a level of purity that was neither intended nor realized. The use of technology in the theater is nothing new. As early as Greek times the masks that the actors used were carefully formed to help project the actor's voices. Even Vitruvius taught that bronze vessels should be placed below the seats in the theaters "then when the voice of an actor resonated with the same frequency as the vessel it would amplify the voice and reach the ears of the audience with greater clearness and sweetness". (The fact that in reality bronze absorbs sound and does not add resonance detracts nothing from the intention.) Indeed, throughout history theater has embraced the most current technologies to achieve its ends.

There are those who believe that the improved attendance at theaters and the resuscitation of their prestige is dependant entirely on the successful and innovative use of technology. Certainly an audience who is accustomed to high quality stereo sound will not be easily placated with a low level of acoustic performance in a theater space. It is suggested that in the theater of the future sound will be better used to underline dramatic intentions giving a much more active role to the sound designer who would become another performer in this endeavor. Thomas claims that the implementation of sophisticated audio systems, coupled with their creative use, have the power to create new theatrical experiences far superior to any we have yet experienced. So much so that "theater has great potential to undergo a renaissance in this country and... theater may indeed replace the movies for the average American family's typical night out."
With the wide range and power of technology available to the designer today part of the challenge lies in deciding what not to use, in finding a way to integrate the technology within the theater construct without allowing it to completely supplant the performance as the focus of attention. Hall explicitly warns against the implementation of excessive acoustical design at the expense of architectural needs such as intimacy or form. He stresses a holistic approach to acoustics when he explains: "as an architect... I have a tendency towards the visual, theatrical and environmental aspects of theater spaces. I prize such feelings as closeness, intimacy, sense of occasion, warmth and sense of community. If in the design of the performance space, these aspects can be realized, I believe that the vast majority of audiences may not really appreciate the nuances or marginal differences in acoustical quality; but because of their surroundings they feel they can." 14 A similar illustration of the psychology of acoustics is given in the description of the impact of using wood on the interior of concert halls, which, though it does not scientifically improve the performance of the space is thought to do so and therefore "can impact reception of a space - even to the extent of actually causing improved performance by musicians."15 Ando goes so far as to advocate a certain sense of discomfort in the theater which would set it apart from the casual enjoyment of entertainment in one's own living room. By making modern theater so controlled he believes that the immediacy that makes theater is removed.16

Making theaters financially viable

One of the greatest challenges in the design, construction and management of a theater venue is the difficulty in making these ventures economical. For McAuley it is the very strengths of theater as an art form that make it financially problematic: "it is this double quality of being both local and located that is the theaters strength in these days of mass media manipulation even though it is also the reason that theater receives far less funding than other dramatic media such as film and television"17. Especially in America where funding for theaters is not provided by federal grants and where the event must be made to pay for itself, theater is forced to become much more commercialized than it would otherwise be. It is a matter of financial survival that forces theater to change so significantly, as Auslander explains: "the general response of live performance to the oppression and economic superiority of mediatized forms has been to become as much like them as possible"18 - theater becomes one media form in a mediatized society. Part of the economic difficulty comes from having to fill large and expensive halls in order to make a production financially viable. This has lead to the stagnation of the theater to the extent that many
smaller productions have had to give way to larger, louder, more spectacular performances.

By contrast new media might not necessitate the enormous up-front investment in its display. According to Mitchell one of the major benefits of information technologies is the fact that the distributed model of supply enables the production of multiple (infinite) shows. It becomes economically viable for a 'show' to be produced that will reach a very small audience. "The Infobahn may become a vast, global Broadway lined with thousands of virtual theaters." 19

It is obviously not possible to create physical theaters in which performances can be staged for audiences of one or two. However smaller auditoria that are combined to form 'performing arts centers' are becoming more popular precisely because they afford the opportunity to stage smaller performances while getting financial support from their inclusion in a larger complex. The ‘cultural theater center’ typology has developed with a makeup that consists usually of one main theater (opera/large proscenium theater) and smaller drama and experimental theaters, for example the National Arts Center in Ottawa consists of a 2300 seat opera house, a 900 seat drama theater, and a 300 seat experimental stage.

In order to raise funds for the construction of large performing arts venues it is necessary not only that the building will be able to run at a profit in the future but also that there will be some benefit to the community who are assuming much of the up-front cost. While the unquantifiable cultural and social benefits are of course important these are not generally reasons that can raise sufficient cash to allow such undertakings. It is hoped that with careful planning the theater complex can include sufficient public draws so that it becomes a center for entertainment. This hope goes so far that Performing arts centers are built with the intention of reviving cities and rejuvenating urban areas – which is an enormous burden on them. They are supposed to create work and improve the economy as people spend on food, lodging, transport. We have seen, however that interest in performing arts is lower than in previous times and that the competition of other media has made it increasingly difficult to fulfill this role. However, Russel believes that some of the problem is also that the theater groups do not make sufficient effort to market themselves, “to reach out.” He is referring here to such projects as Kennedy center’s millennium stage with free concerts, pay what you can evenings, half price tickets that can be purchased on the day of the performance, more diverse programming, and actively helping other communities – often those with less tradition of attending theatrical events - to build audiences. Architecturally he sees that “the need to make such facilities a kind of urban magnet has made overtly spectacular designs more appealing”20

“I gave myself great pains to master this bizarre science, but after fifteen years of labor I found myself hardly in advance of where I stood on the first day... finally I made this discovery. A room, to have good acoustics, must be either long or broad, high or low, of wood or stone, round or square...”
Charles Garnier
1889

thinking about theaters: making theaters financially viable
Theater designers have often made this role explicit in the building, creating a fantastic, elaborate structure. Yet, one problem that arises is that in the creation of a glamorous and magical building we run the risk of instilling in people the feeling that the theater is an elite institution. It is not the dramatic act by itself that is seen to be elitist—for our culture displays many examples of theatrical events occurring in relaxed, popular settings. However, there is an implied difference between these more casual theatrics and the performances of ‘legitimate theater’, which are produced in the strict confines of “fixed space theaters”. While Schechner is not advocating the removal of theatrical venues he is asking that we allow some of these more casual manifestations to filter through into our performance centers. His requests are seemingly simple, for example, that people be able to eat in the theater and that the venue be more flexible so that each production would necessitate a creative restructuring of the space. As well as drawing from popular culture this introduction of a less rigid use of the theater also recalls the use of theaters in previous times as well as the events staged in other cultures.

Furthermore, it is important for the designer to remember that the cultivation of this glamorous, ‘magical’ theater space is a carefully constructed image that goes only as far as the spaces the public has access to. A large part of the building is given over to the ‘real world’, and, for the individuals working in the theater the spaces are often cramped and bare. Often it is in these spaces that money and volume are carefully rationed. The impact of these backstage areas on the actors and therefore on the production is important to remember. The provision of common spaces for the actors for example creates a sense of community that can directly translate into a better performance.

For the public the creation of this theatrical space begins the moment one enters the theater building. In fact for McAuley the very meaning of the theater is to signal the removal of the theater from the world, ‘the principal function of the primary framework constituted by the theater building is to signal to all concerned that, once inside, we are in the realm of ‘denegation’, an equally important one is to set in motion the spectator’s work of meaning making.’ But the creation of this theatrical space is not completed in one sweeping move; rather the space defines zones and provides a series of thresholds that serve to allow the audience entrance into the fictional world. Some of these thresholds are physical—such as the building itself and the often
grand staircase, the proscenium arch and the theater curtain while others have more to do with the ritual of the event, the need to purchase the ticket, receive a program and have the usher show one to one's seat. In addition to creating a space inside the theater for the performance, the building also serves as a protection of the outside world from the theater. In earlier times this was overt – the globe theater in Elizabethan England was placed out of city limits, across the Thames and the need to protect society from this debauchery was seen to be very real. Today we can embrace theater as an art form, yet we need to know that it will remain within its defined space so that the boundary between fictional and real does not move closer to our everyday world.

Another important function of the building is to create a space in which the individual spectators can be somehow formed into an audience. Again the procession of spaces allows for this to occur. The lobby plays an important part in this formation; it is here that the individuals congregate both before the performance and during intermissions. It is here in the lobby that the theater goers can see and be seen, taking the time to watch the spectacle of the event itself, the socializing, the fancy clothes, the drinks at the bar, the theatricality of it all.

The creation of dramatic space that begins at the entry and with the lobby has its focus in the auditorium itself. Many contradictions need to be resolved in the design of this most important space. There is the problem of keeping the auditorium small enough to create a feeling of intimacy without making it too small to survive financially. For McAuley this contradiction is the result of a divide between practitioners of the theater art and those who are more interested in money and prestige. She claims that “the move to increase the size of the theaters has usually come from architects with grandiose visual ideas and from profit-hungry management and has usually been resisted by actors who want spectators to be able to see the details of the facial expression and to hear the subtleties of their vocal delivery.” Fortunately, as I have already discussed there are ways to provide for smaller venues within theater complexes so that these can be financially viable.

Another of the contradictory notions inherent in the design of a theater is that the building needs to be spectacular, the space must assist in the creation of the event, the splendor, the style and on the other hand there is a need for a space which is small, intimate, where the 'real' quality, the intimacy and emotion can be conveyed by the actors and easily read and understood. Initially it appears that the solution is to make the lobby glamorous and grand while keeping the auditorium itself very simple so as not to distract the audience's attention away from the performance. However there are problems that occur when the auditorium is designed in such a

I look for places which were not intended for the theater. The theater is the last place where one can produce a play”
Tadeusz Kantor
1989
quoted in Breton, G. Theaters
way. McAuley refers to the theory of the information rate of space – the amount of information in a place – e.g.: color, image, shade, and form. According to this theory the less information am space contains the more bland it appears and – as a consequence – the more passive users of the space become. This idea has found adherents in hospital design where the bland white walls were found to make patients too lethargic to recover and the institutions began to introduce bright color into the environments.

The role of the audience in the theatrical event is clearly important, the responsiveness of the spectators is what allows the actor in turn to respond, and therefore makes each performance unique, and sets theater aside from so many other media. It is therefore very important that the audience not be lulled by an excessively quiet environment into passivity, they need to play an active role. Fortunately this does not mean a return to Baroque excesses in the theater interior since spaces outside the auditorium - restrooms, bars, restaurants, box-office - have been proven to contribute to the reactivity of spectators.

Even within the auditorium there is a clear progression of spatial hierarchy. First there are the various seating locations which, no matter how well designed the space, will always result in some better seats than others. While this is usually a factor of better acoustics and vision it can also be a result of issues of complex social rules. For example, although the seats are all focused on the stage, in some seating layouts there is more chance for the audience to be visible to others across the hall. It has often been more important to be seen in the theater than to see the performance – the boxes for the use of the privileged guests were designed with this purpose most clearly in mind.

Nevertheless the main focus of the auditorium remains the stage. And it is therefore not surprising that much attention has been lavished on the spatial moment where the stage and seating meet, and much philosophizing done over its nature and meaning. The most common, and the most traditional way of defining this meeting is by using a proscenium frame to separate the fictional from the real. But historically, and again more recently, there have been other models – so that in the most 'experimental' of venues the stage can be located anywhere in the space with the seating similarly flexible. In all cases the architectural decisions reflect a philosophical viewpoint on the dramatic intention.
All the options

Given that there are so many contradictory notions of what theater means in our society and what will become of this form of entertainment as our mediatized world becomes more removed, I do not believe that the theater designer should attempt to answer all of these questions. Rather, the venue should provide a space in which these questions may be asked so that it promotes an expanded awareness of performance in general and allows for spectators to construct their own image of this art. One way of achieving this end is the use of the smaller stage spaces and alternate performance venues described above. Another would be the incorporation of flexible dramatic spaces such that each director can influence the architectural design of the theater depending on the specifics of the performance to be located in it. Theaters should allow for the most traditional of productions but also be open to many kinds of new interpretations, new technologies, and new relationships.
Notes

1 Quoted in Liveness: (Forced Entertainment 1996:87)
2 Carlson, quoted in McAuley, p37, 1989
3 While it has often been assumed to be true that the introduction of new technologies negate the value of the old, the facts do not bear out the assumption. For example, many of the early predictions involving cyberspace have not proven themselves to be true. It was, for example, believed that increased telecommunications would result in less need for face-to-face communication and therefore less need for transportation. Yet the reality was that new methods of communication actually led to an increase in transportation needs. While the relative share of transportation declines the absolute level of all communication will continue to rise. Graham and Marvin discuss these phenomena at length in their Telecommunications and the City. "Interactions between telecommunications and infrastructure networks can be most accurately characterized as one of interdependence, complementarity and synergy. The first form of interaction is enhancement... increasing use of cheaper telecommunications services helps to increase the number of people in a network and knowledge about the availability of goods and services. This information can then result in an increased desire to travel in order to have a higher level of personal interaction. The development of the mobile car phones, for instance, may actually stimulate more travel as new trips can be generated during a car journey." p283. They point out that this phenomena is not a new one and give the example that "the first words spoken by Alexander Graham Bell into the telephone he had just invented were, 'Watson, come here I want you.' "quoting Mokhtarian, p285.

In the realm of theater we have one good example of this in the statistics for theater growth in Tokyo city. Tokyo is one of the contemporary 'global cities', and a place that has embraced new technologies and led the way for their implementation. Yet in Tokyo the audience for traditional concerts is growing rapidly, there are a large number of Japanese symphony orchestras, music conservatories, and much public patronage of its concerts. This fact seems to point to the possibility of mediatized and traditional entertainment co-existing, and although this example is taken from a culture very different from the American location for which I will be designing it is nevertheless an important observation.

In this volume Baur-Heinhold gives a beautiful and full picture of the role theater played during this time.
5 Auslander. P.27
6 Hall, B.
7 Mitchell, W. City of Bits p.65
8 Auslander, p.3
9 Contemporary theater: evolution and design: athanasopoulos
10 Auslander, p.7.
11 Auslader, Liveness, p.4
12Quoted in : Concert Halls...
13 The Present and Future of Audio in the Theater. R.X.Thomas pp. xxxiii
14 Hall, B. p.xvii
15 Hall, B. p. xviii.
16 Perspecta 26: Theater, Theatricality and architecture 'Kara-za, a movable theater: an interview with Tadao Ando' p.171
17 McAuley
18 Auslander, p.7
19 Mitchell. P.65
20 Architectural Record, May 1999 -- Building types study773:Performing arts centers
using art to revive cities p.223 -- james s. russel
21 Schechner sites themeparks and restored villages as examples of these.
22 Perspecta 26: theater, Theatricality and architecture P97- interview with Richard Schechner
Theater literally comes from the Greek: a place to see’ which underscores the relevance of the spectator.

ibid P59
A brief history of Boston's theater district

The history of Boston's theater begins with a lack of it since the Puritans banned theaters until 1792 in the city. The first theatrical productions to be allowed in Boston were produced under the guise of being 'moral lectures', but despite the necessity for this ruse theater had taken its first grip on the city. The first dedicated theater building opened in 1794 and was called the "New Exhibition Room" – a name which illustrates the continuing necessity for Boston theater to present itself as something else. Even in 1841 the main theater of the day was the "Boston Museum", which was attended by those members of high society who, although they would not attend a theater production, felt justified in coming to this museum. Theater was censored in Boston until the 1970's. Eventually however, despite the watchful eyes of the Watch and Ward Society and, later, the mayors office which censored Boston's productions, the city became the biggest try-out location for performances destined for Broadway. The idea being that Boston's audience provided a cheaper alternative test ground where the show could be fine tuned before its appearance on the nationally important New York stage.

Until the beginning of the twentieth century there were two distinctly different kinds of theater buildings in Boston that provided entertainment to different parts of society. The popular theater took place in simple, functional structures and housed events that were pure and simple entertainment. However since the Proper Bostonians would not even enter such establishments theaters were built for them which were grander and more institutional, the legacy of the Boston Museum. By the 1900's however theaters were built which were grand but still offered accessibility for all the cities social classes, these 'palaces of the common man' were hugely popular in Boston.

During the 1920's the theater district housed up to 40 theaters in a small area of the city. And, in 1935 - even though it was the middle of the great depression there were a total of 55 theaters in the district. However the decline of Boston's theater culture came soon after and is attributable primarily to two causes. The rise of film and later television led to a decline in popularity of live productions. Many of Boston's grand old theaters were renovated as movie halls but these too shut their doors as the modern Cineplexes gained popularity. While many of these fell into disrepair and eventually were torn down, some were later renovated and survived for the theater going public. The decline in theater due to newer forms of entertainment is a factor that has effected the reception of live performances globally. In the case of Boston there was an
Map of Boston's historic theaters. fig 12 reproduced from Norton, E. *Broadway Down East*
Map of Boston's current theaters. Fig 13 from a series of maps reproduced from www.mapquest.com
additional reason for the drop in the number of productions as the city's identification as a try out
city began to lose ground. New York producers began to stage their plays in Philadelphia and
D.C. which were often cheaper, or had locations which offered them some enticing package deal;
furthermore the theaters of off-off-Broadway began to be used as testing grounds that were much
closer to home, and therefore much cheaper to use.

Today there are over 30 theaters in Boston, with many others in neighboring Cambridge,
Somerville and in the outlying suburbs\(^2\). The vast majority of Boston's theaters are still distributed in
the Theater District. There are other clusters of theaters around universities, with Boston University
housing several. In Cambridge a large cluster of theaters is situated around Harvard Square.
Many of these theaters are tiny, the majority housing fewer than 100 spectators. Of Boston's larger
theaters the Wilbur (1200 seats), the Wang (3700 seats), the Schubert (1680 seats), the Emerson
Majestic (850 seats) and the Colonial (1658 seats) are all in incredibly close proximity within a
couple of blocks in the theater district.

Given the intensity of this cluster of theaters in the theater district there is surprisingly little
'theater culture' in the area. Several of these theaters have disproportionately small lobby spaces
and none of them have connected restaurants or commercials spaces. The flood of audience
members leaving the theaters and moving rapidly to the subway stations and parking lots attests
to the general habit of Boston theater goers of going to the theater and leaving immediately after
with little lingering in the area.
The site today

The site for this building is in the Theater District, which is one of Boston's most vibrant areas especially in the evenings and on weekends. There are numerous restaurants, bars and clubs in the vicinity in addition to the theaters that range from Boston's largest, the Wang, to the smaller theaters and comedy clubs that are located all around. Because of the range of entertainment in this small area the theater district attracts a very diverse group of people.

In this area of Boston the various districts are located close together. The site is in walking distance of most of Boston's downtown neighborhoods – including the Financial District, Chinatown and Back Bay. The site is also very well located for access to public transportation, with both red and green line subway located on the edge of the Boston Commons, which is only one block away from the site.

The building will inhabit what is currently a parking lot at the corner of Tremont and Stuart Streets. The site is a polygon with its length ranging from about 200 ft at the back to about 240 ft in the front of the site and with a width that averages 150 ft. It faces onto streets on three sides: two of these being main thoroughfares in the district. Tremont Street leads from the Boston Common up toward most of the main theaters of Boston. While Stuart street runs from downtown Boston, through Chinatown before arriving at the theater district and then continues in the west toward Back Bay, and the restaurants and shopping locations of Newbury street and its surrounds. On the West the street onto which the site faces is a small alley – Warrenton St, or Shear Madness Alley, named after the long running performance that takes place at the far end of that street. This street is partially inhabited by the rear entrance to the Schubert and thus populated by the stagehands and hidden world of that theater. The alley does however also provide the front entrances for several smaller theaters and bars. On the fourth side the site is bounded by a high and almost continuous brick wall which is the back wall of the Schubert theater, the change in elevation of this wall reflecting the presence of the Schubert's stage and fly tower.

Warrenton street meets Stuart street at a T and faces the enormous bulk of the Massachusetts Transportation Building, while an attempt has been made in that building to provide an interior street that connects Boylston street and the common with Stuart street it is a largely underused passage and one which many people forgo in favor of taking the long – and more pleasant –
aerial photograph of the area of Boston surrounding the theater district. Fig 14 taken from Mass GIS at http://maps.massgis.com
way around. The scale of this building is in contrast to the rich and varied texture of the structures to the east and south of the site and does not promote a pedestrian culture or accessible feeling. However the row of restaurants which inhabit its ground floor area do attract many customers who will have a view directly toward the site and past it to the rest of the theater district.

photograph of the site taken from the corner of Stuart and Tremont: with view of the back of the Schubert theater on South of site.
site plan of theater district with arrows showing direction of views on following page
Talia Braude

the theater complex
Program

The formation of the program for my building is based on my research about the site and the function of the theater, as well as on my personal experiences as both a theater goer and as a performer. The creation of this program was a complex design exercise that was very closely related to the development of this building. Many of the ideas about the relationship of the building to the city and more specifically to the theater district, the relationships between the spaces, and the nature of the different spaces was formed as I formulated this (program) and the program was similarly to change and evolve with the development of the forms and the spaces.

My intention in designing a theater complex for Boston was not only to provide the performance spaces themselves, but more importantly to create spaces in which theater can be explored, in which the event of going to the theater can be celebrated, in which the enthusiasm for performances of all kinds can be shared... in other words a place to promote, revitalize and reinvent theater culture.

As such it makes sense to place the building in the heart of Boston's historic theater district for several reasons. The site is at the core of the district where Boston's theaters have been located for over a century. As such it can draw on and re-invent this history. The crowds of people moving to and from the other theaters in the district will be the natural beginning of the inhabitation of this building.

Indeed, the siting of this theater in the "theater district" of Boston has had much effect on my ideas about the program for this building. It is my belief that this building should be made a part of larger theater system and not designed as a completely independent structure. The advantages of this are many: for the district it will mean a new public face for the theater which will be a way of drawing an audience into the area, igniting renewed interest in the dramatic art and giving a strong sense of identity to the area. For the new theater this will bring a certain freedom in terms of design. It will not be necessary to include a large, traditional stage in the complex as those that are located so close by are well positioned to house those performances that have need of such a stage. This venue will therefore house a greater number of smaller stages and less traditional spaces – a dinner theater/comedy bar, small experimental stage, places for informal productions by non-professionals (school groups for example), outdoor areas for impromptu performance.

In taking on the role of beacon for the theater district there are other functions that are necessary – a bookstore selling all kinds of related products (videos of performances, literature,
souvenirs, etc.), a space for lectures and discussions about the performances, a new and more visible, and visually pleasing ticket booth to replace the old one on the street corner directly across Tremont street from the site. Billboard walls that are integrated into the building rather than appended to it can be used by various theaters. Additionally a café and restaurant with high visibility will create an atmosphere of bustling inhabitation. As McAuley points out, the bar-restaurant, are not only good business ventures and convenient locations for theater goers, they also signal the connection of the theater to the leisure industry so that going to the theater can be seen as a complete 'good night out'. Seeing theater in this light makes drama seem more accessible and even has an impact on the kinds of theater produced.

If one role of this theater is to open up the theatrical process to the public then the sharp division of space that is usual between actors and public need not be so forcibly upheld. In introducing the possibility of glimpsing back stage and observing the workings of the theater it is necessary that the sharp contrast in the nature of these spaces also be somewhat revised. Although there is no intention of creating the kind of magic and glamour in the backstage as are conjured up out front, it is nevertheless important that these backstage areas be architecturally well-designed and not the cramped and uncomfortable spaces that they have often turned out to be.

On pages 50-51 is the theater program that I developed for the project and that has guided my design (although it has not been rigidly pursued)
Computational Design of a Theater Complex for Boston

Gehry’s Walt Disney concert hall contains a pre-concert amphitheater for lectures and meetings as well as a museum, restaurant and gift shop.

fig 15 reproduced from Steele, J. Theater Builders

Wilford’s design for the Lowry Center includes upper level balconies and galleria with connections to the theaters and views of the city skyline.

fig 17 reproduced from Steele, J. Theater Builders

The plaza outside the Garnier Opera house and the steps leading up the building are a popular gathering place.

fig 16 reproduced from www.paris.org/Monuments/opera/gifs/opera.garnier.html

Utzon’s Sydney Opera House with the strong base connecting the opera and concert hall and the city below.

fig 18 reproduced fromonot, F. Jom Utzon: The Sydney Opera House

The Cardiff Bay Opera House designed by Hadid includes spaces for outdoor performances and has a strong connection to the plaza and the bay.

fig 19 reproduced from Steele, J. Theater Builders

The theater complex: program 51
500 Seat Theater

- lobby (30 X 60)
- stage (50'X 25') + 20' either side : fly tower 65' min to grid + 10' additional to roof
- office for assistant house manager (300sf)
- technical office (300sf)
- concession stands/bar in lobby
- wc near stage (but acoustically isolated)
- coatroom/restroom
- greenroom (20 X 20')
- 2 large dressing rooms (25' X 40') w/ w.c. and shower
- 4 small dressing rooms (8 X 10') w/ 2 shared w.c and shower
- make-up/costume room (8 X 10')
- dimmer racks (6 X 8) closet
- sound booth/light booth/stage manager all back/above w/ vis to stage

200 Seat Flexible Theater

- lobby
- office for assistant house manager
- technical office
- concession stands/bar in lobby
- wc near stage (but acoustically isolated)
- coatroom/restroom
- greenroom (20 X 20')
- 2 med dressing rooms (15' X 20') w/ w.c and shower
- 2 small dressing rooms (8 X 10') w/ 2 shared w.c and shower
- dimmer racks (6 X 8) closet
- light/sound booth?
- (if moveable seats must have storage space for additional seating)

Dinner Theater/Bar

- Lobby space
- office (400sf)
- wc near stage (but acoustically isolated)
- coatroom/restroom
- greenroom (20 X 20')
- kitchen (1000sf)

Back Stage

- w/ separate entrance and loading dock.
- storage areas for props (the bigger the better. (min 25'X50')
scrims, backdrops, masking drops, etc (12'X 30')
lights (25 X 50')
costume storage(min 25'X50')
stage machinery?
rehearsal space (eq to size of stage + surround)
1 @ 1800sft
2 @ 1200sft
workshop (25' X 25') (most work done off site at cheaper location only
some done on site at last minute)
costume shop (100' X 50')

- **Offices:**
general/reception (500sft)
artistic office (main, director, general) (300sft), (500sft)
literary director (300sft)
business office (3 people)(500sft)
development office(500sft)
marketing, publicity, graphic designer (3 people) (500sft)
stage management (300sft)
production manager (300sft)
box office manager (300sft)
house manager (300sft)
educational outreach (500sft)

- **Other Public Spaces:**
restaurant (indoor and outdoor seating) (2500sft)
ketchen (1200sft)
restrooms (500)
bar (3500sft)
restrooms (500)
book store and gift shop (50' X 25')
public space outside, casual performance spaces.
'bostix' booth (15 X 30)

- **Other Considerations**
mechanical (4000sqft)
Parking (underground, replacing existing)
Screens / billboards

[denotes spaces that are shared between more than one venue]
The manipulation and organization of the various parts of the theaters developed concurrently with the form of the building. Because of the complexity of the program and the necessity to house support spaces for three theaters and the restaurant as well as all the administrative functions of the theaters it soon became apparent that some large organizational gesture was necessary to avoid an overly complicated layout. The decision was made to unify these support spaces significantly and allow them to be massed along the back of the site, and also (although to a lesser degree) on the ground floor level in the spaces not occupied by public functions -- areas below the stage for example. By arranging the complex in this way the support spaces form a strong background against which the theater of the space can unfold, the backdrop of a stage against which the stage set is presented. The entries to the back area, both access to the offices and backstage and to the loading dock are located at the back of the site in the area least intrusive to the public spaces. These entry ways are the two private entrances into a building which has many public means of access.
Access and flow

The theater complex is intended as a beacon, a building that entices people, and then unfolds to share its many ideas about what theater can be. As such the building can be approached, and entered, from many places: sometimes the entries are grand and obvious, other times they are quite small, just places for people to slip in, almost without realizing it. The most pronounced entrance is the main plaza on the corner of Tremont and Stuart street, which faces predominantly onto Stuart. On Warrenton Alley there is an entrance which allows access directly to the interior plaza and is also very close to the dinner theater. This access allows the entrance to that theater to be located along the alley where other similar venues are found. There is also an entrance here into the office/support building behind. From the back of the site on Tremont St is another set of stairs that lead the visitor by a longer route to the main lobby. Another entrance sequence that is vital is that from the parking below, the access from here is directly into the main lobby, joining the existing crowds: even those who park below with no intention of attending the theater or enjoying any of its facilities are made to wander through the theater complex: access and flow.
The lobby to reach the streets, enticing them to become part of this theater community.

**Technology in the complex**

The theater traditionally uses bright lights and billboards to advertise itself. Often these are not well integrated into the architecture. In this complex this role is taken by compound information walls which are used to display information about the theater events. These walls are of two types, those which face the exterior of the building and are for the benefit of passersby, and to draw them into the theater – in other words, a fairly traditional use of the billboard. Then there is the wall which separates the support spaces from the public spaces and which, for most of its length serves as an information wall. This wall is for the enjoyment of those inside: the function of it is mixed: theater events can be broadcast on screens so that latecomers, or overflow audience can be accommodated. Rehearsals can also be broadcast here – at the discretion of the actors involved - this can range from the display of daily rehearsal to only those final dress rehearsals deemed ready to be seen: this is part of the attempt to open the theatrical process to the audience.
to share some of the excitement of the backstage without losing any of the magic of the performance. The cameras can even be turned on the audience members themselves, making the theatricality of the venue even more pronounced. Or these screens can be integrated into performances.

The screens use a mixture of technologies, billboards can be printed and applied in the traditional manner, the wall has a certain transparency and thus projections will allow for a view of what is beyond while LCD displays are where the behind the stage scene is not to be seen through. Various mixtures of live and mediated are made possible. These walls can be choreographed carefully or left almost to chance.

Public Spaces

This building includes various scales of theater from the most traditional of proscenium stages with an auditorium that seats 500, to spaces that, strictly speaking, might not be called theaters at all. The intention here is to allow for exploration and for all manner of theatrical production rather than attempting to enforce some avant garde notion of theater, or to retreat behind the more traditional, tried and tested approach.
In many ways the main theater of the complex is in the lobby and plaza areas: This space has indeed been designed as a theater, with balconies overlooking the display of life below. Within this expanse of flow space two well delimited theater spaces are found. The main plaza contains a stair case leading up to the upper level plaza, which is more a theater seating than a stair. This reverse amphitheater faces onto the plaza and allows for the viewer to watch all manner of casual performances that occur below. The columns which support the main roof are carefully placed in this plaza to break up the space and create stage areas. In the interior, again, a staircase is expanded as a seating area, these seats also face onto the interior bar below the blackbox theater. The ‘stage’ here can also be seen from the balconies of the lobby. The action on this ‘stage’ unfolds against the backdrop of the information wall behind. It is less likely that actual performances will take place in this space, though some might be planned by the theater groups, and casual performances would not be precluded in this area, but even without such specified activity, the space will be such an active part of the theater that there will always be something to enjoy.
Computational Design of a Theater Complex for Boston

Since much of the flow leads the visitor upward to the main lobby level there is significant space freed up at the ground level for related uses. On the north west corner is the restaurant which opens directly to the street and can also be accessed from the main plaza. This restaurant also has seating above, on the open deck, which connects back to the dinner theater with which it shares a kitchen below. This dinner theater is the most casual and experimental of the three formal theaters, and as such is the most open, with connections to the lobby and to the restaurant, so that audience members can flow through the space. Other public functions of the building are woven in among the flow space: including retail spaces accessible from both the ground floor and the lobby area.

The balconies into the lobby are part of a large open area which is vast in its volume. However these lobbies are broken down into smaller spaces by walls which flow around them, sometimes rising only to the height of a railing and other times enclosing a small room. As such the ability to see the stages below, (the wonderful views of the city, the action in the lobby) is one which opens and closes as one moves through the space.

Structure and construction

The flow of the public through the building is what defines the lobby space, much time was spent examining this flow space. The roof over this area is both symbolic of and necessary for the existence of this dynamic space. The roof is made of beams and cross beams traveling over the lobby in both directions, yet the main direction of the structure is in the main direction of the flow of people below. The roof is low over some of the balcony spaces, so much so that it becomes, along with the balcony walls, a defining edge of the spaces above, in other places the roof is extremely high, especially over the interior plaza. It is in this space that the roof structure is brought down as a column, which is both necessary for the structure but more importantly it is important in the definition of the space below. The roof structure is covered with translucent panels which allow the light to pass through creating rhythmic shadows and a very dynamic space below.
site plan
diagram showing all entrances to the complex
diagram showing theaters: formal and casual
Computational Design of a Theater Complex for Boston

plan of main lobby level

a: main plaza below
b: raised plaza
c: large theater
d: main entry
e: lounge/bar
f: restaurant deck
g: dinner theater
h: lobby
i: indoor plaza
j: green room
k: stage
l: quick change/make-up room
m: workshops

the theater complex: plans
plan of parking: level -2

a: parking
b: ramp to below
c: mechanical 1.
d: elevator to theater levels
e: storage
f: fire stair
section AA - through main theater, lobby and service block.
Computational Design of a Theater Complex for Boston
the design process
Introduction

The process by which this design developed was, like any design process, a non-linear one. As such it is difficult to show the process in a very methodical way. On the next pages I have put several 'stories', each one dealing with some aspect of the process, the work is sometimes repeated in more than one story, the times at which they took place overlap. But paging through them will give some sense of the unfolding of this design, and of the process that this thesis addresses. The stories are titled as follows:

- sequence of models
- sketching with scripting
- selecting software
- the flow story
- CAD/CAM
- putting the 3D-model to work
- talking and sketching

In discussing the process I have tried to show both the positive and negative aspects of the use of the computer and the shortcomings of this design methodology as well as to give my ideas about what the next step would entail.
formal investigations using 3d-studio

first massing model showing three theater volumes and plazas

reorganization of theaters/plazas; addition of information wall and lobby balconies.

introduction and organization of support volumes - massing study

the design process: sequence of models
Computational Design of a Theater Complex for Boston

sectional model of support volumes, study of flow and interconnections

1/16" = 1' model: relating interior of theaters to lobby, plazas.

accurate model of theater volumes and spaces between, introduction of back building for support spaces

mixed cad/cam and hand made model: shaping of entry plazas and flow spaces

the design process: sequence of models
renderings of interior: study of materials, light.

roof surface flowing between the forms. billboards, stair/theaters

jump in scale: interior of lobby: control of roof forms

sections showing three part division of roof, relation of theaters, plazas, lobby.

the design process: sequence of models
combination of laser cut roof with additions of pipe cleaners.

reorganization of entry sequence, ground floor volumes and vertical circulation.

model showing version of theater complex at final presentation

site model with cad/cam roof surface

the design process: sequence of models
Sketching with scripting

The drawings on these two pages were created using scripts written in Vectorscript. This is the programming language that is used with the Vectorworks CAD software: it is a language based on Pascal.

I use this tool for making sketches - by which I refer to the fact that these drawings are ambiguous, conceptual and help me to think through my ideas while I work. It is possible to utilize this tool to explore concepts, to clarify ideas, to test texture and later to refine the design.

There are several advantages to writing code rather than drawing directly. Each time one runs the code one receives a different output - these vary within the constraints that are encoded. By fine tuning these constraints one refines the design and clarifies one’s intentions.

What I refer to as a sketch is not one line drawing, not the specific output of one running of the code, but rather the multiple ‘runnings’, the range of possibilities: even the future outcomes that we can begin to imagine are part of this set.

This method is one way of using the computer which addresses the critique of
the machine as being too accurate for initial phases of the design. The problems with this system however are that it is relatively time consuming, and, even though one can often create drawings/objects that are different from those that the cad program, used traditionally would allow, one is still limited to the language provided. Vectorworks for example cannot draw nurb surfaces. Both AutoCAD and 3D-Studio have programming components: Autolisp and MaxScript respectively, but while these offer increased opportunities they are correspondingly more difficult to manipulate. Coding is a very powerful way of working but perhaps the ideal situation is for the designer to work in conjunction with a programmer who can more quickly write the complex scripts that can keep up with the design development.
Selecting Software

When I began this research part of the goal I articulated was to find a design process which enabled me to move between the computer, physical model and hand drawings based on the questions of the design and the intuitions of the moment. Of course I knew that to use the computer was not a singular idea and that the designer needed also to choose instinctually what computational process to use. However throughout the development of the thesis it became increasingly clear that the choice of software is a design decision which can impact the development of the project substantially.

The choice of what CAD program to use is much like the choice of what physical material to use when making a model. Manipulating a surface in Rhino is much like playing with fabric - each part of the surface can be manipulated through control points and affects only the other points in the immediate neighborhood. Working with the same surface in Mechanical Desktop has a very different result, the surface responds less fluidly, more like paper, or even metal.

The first program I used was Teddy - developed by Takeo Igarashi - this program was created for children and is used to make 3d-objects (teddy bears, for example) with which to populate virtual worlds. The software is incredibly simple and intuitive, which makes it very powerful. I used it to play with basic forms during the initial stage of the design.

VectorWorks I used for scripting -- infact I do not know how to use it traditionally since I have never used it to draw with. On pp.74-75 there is a discussion of this use of the software.

Rhino and Mechanical desktop were used for a majority of the modelling done for this project. While I have more experience with Mechanical desktop and therefore found it easier to use for much of the routine work, I switched to Rhino for several parts of the roof design, since it is more intuitive to use and offers greater control of surfaces. This is also the software used for digitizing. I worked back and forth between these two programs often.

While people often work to become extremely proficient in one software package it seems to me that this is not the most efficient way to use CAD. Rather the designer should learn to feel comfortable with new programs, should keep up to date with newly developed software and new tools in existing programs. Working in this way, while it might look less 'professional', allows the designer to retain control of the process rather than surrendering this to the software engineer and the question of what the software was written to do.
My study of the flow space in the end was done through both virtual and physical model making and served as a general conceptual exercise and inspiration rather than a direct form finding pursuit.

The flow story

Much of the design development focused on the spaces between the theaters: the lobbies, the plazas. These spaces are the most dynamic in the building, the places where people enter and exit both the complex as a whole and the individual parts of it. It is the space of connections, of relationships, of flows. In order to study this space I explored a number of tools. I constructed the flows in 3d-Studio - using particle systems to simulate the movements. However this process is limited by the fact that the movement is not based in the actual interactions of people in space - nevertheless it can be used to clarify intent and concept. Programs using reality based algorithms to develop crowd simulations have been developed and I hoped to use one of these in my design. Unfortunately it was necessary to have a detailed plan to begin the study with - rather than developing the plan from the study: furthermore I did not have direct access to this tool but would have had to send my documentation to the administrator of the program.
After exploring the most general form of the roof in a physical model, a computer model is created. The imposition of mathematical constraints and the necessity for specificity generate the next version of the roof surface.

The first method for outputting the virtual model is by making a fusion deposition model. This manufacturing method captures the form of the surface well, but does not simulate the full scale construction method for the roof.

The next physical model is edited: the physical model gives a better sense of the totality of the form and the relationship of the roof to the rest of the building. This model is then digitized and the next generation computer model can be created from this data.

The computer model is used to create a physical model using the laser cutter. Shapes are curved in two dimensions only, simulating the reality of the steel members. The laser cut beams are formed into the continuous surface of the roof.
CAD/CAM

There are many reasons for having physical models in addition to the virtual versions. No degree of representation of the virtual model, no matter how skilled the rendering, can match up to the value of having a physical model in one's possession. The physical model allows one to make quick and intuitive manipulations and additions while seeing the building in its entirety and in its context. Producing physical models that are consistent with the design necessitates the use of various forms of manufacturing. The process by which one makes models at early stages of the design process has an impact on the way in which the design develops. I propose that to develop the design using CAD/CAM tools for the manufacturing of conceptual models will lead to a design which will incorporate these basic ideas of manufacturing in the final product. This will facilitate using these same manufacturing tools at a later stage for the development of details, for working out construction of the building, etc. Using the laser cutter to cut the beams for the model is a much more useful simulation of the process of making the steel beams for the building than making those same forms out of plastic on the 3-D printer would be. The fusion deposition modeler (3-D printer) is useful in other ways, it can output complex forms and surfaces that would be easily produced by traditional means. While this method of making models is currently extremely slow and time consuming the technology will certainly improve and make this an increasingly useful way of working.

In addition to outputing the virtual model to physical form it is often necessary to work from the physical model back to the computer. Here the use of the digitizing arm was fundamental to my process. The splines created by the digitizing process needed significant editing in order to render them useful. To make changes to the roof a digital surface is needed, rather than a series of splines, and the construction of this surface from the points digitized is a complex and time consuming task.
the design process: putting the 3d-model to work
Putting the 3D-Model to Work

There are many advantages to building a 3D model -- after it has been constructed the designer can use it to output many different types of drawings as well as to construct physical models using CAD/CAM techniques. The methods I used to move from the virtual to the physical model have been documented on pages 73-74 so I will not deal with them again. Rather I will explore the types of drawings that I have produced directly from the virtual model. Sections and plans can be created by slicing through the model, and I often use these with elevations or perspectives to create a sense of the totality of the space. Renderings, and line perspectives are also excellent ways to explore the experiential nature of the space. Given the amount of time that realistic texture mappings and photo-finish renderings take I have never found them to be a useful design tool. While these can be very helpful in presentation, they seem to me to be better left to someone other than the designer. Here I show three examples of perspective drawings created in 3d-studio: a very basic material mapping on the top, and a line drawing and composite rendering below.

In order to make use of the virtual model it is necessary to take the time, often, to stop and examine this kind of output. I found that during the course of the thesis development I did not take sufficient advantage of this method, I tended to feel that taking the time to do these drawings was time that I should instead have been spending on changing the design, but without the ability to learn completely from the project as it develops it is not possible to move forward with the design.

In making sections and plans I have found that the creation of the slice is only the beginning of the process. It is necessary to take the 2d drawing that results and edit it significantly. To make the virtual model sufficiently detailed that slicing plans and sections would immediately result in sufficient quality to simply use these as finished drawings is unrealistic. In going over the drawing manually to refine it one insures that the computer drawing is not allowed to seduce one such that one does not control or understand it despite having conceived and designed it.
Talking and Sketching

One of the current limitations of designing on the computer is the need to stop and plot drawings in order to discuss them with someone else or to get a sense of the whole for oneself. This is necessary for a number of reasons - probably all obvious ones. The size of the screen, no matter how generous, is limited relative to the large plot that is possible, and the ability to draw over the printout is invaluable. It is also extremely important to have multiple drawings available to compare and move between while talking.

On these pages are several sketches that were produced during the course of the semester. Some I worked on while sketching quickly over printouts, or making notes for the construction of models. Others were the result of conversations with Fernando - and these were drawn by him also as he and I talked. They are frozen records of our discussions, somewhat ambiguous now, although as I look back at them they serve to remind of our conversations. Moving back and forth in drawing is much easier to do than in model and so printing and sketching, scanning and drawing were an integral part of the process.
the design process: talking and sketching
conclusion
**Speed, stealth and slowness**

When I began this thesis I was often asked how I was going to prove that the design was better as a result of using the computer in the process. But this was never the intention, rather I am glad to say that I feel that the design could not have become what it is if it were not for the process that I used, and that, indeed, the computer was integral to that process. In my explorations I made many discoveries about the way I work, the way I use the computer, the things I can continue to explore for so many years to come. The most important lessons I am learning are these: how to work faster, how to work slower, and how to work worse...

As I put this document together I get a first sense of the breadth of the work and also of the quantity. It is through the act of collating the work that I get a chance to really see what I - with my computer - have produced. It becomes clear to me that this act of compiling, documenting, examining the work is a very important part of the process -- more so when using the computer than otherwise. It is so easy to produce images quickly, from the 3d-model, or using collage techniques, or by rendering, slicing, etc; yet these are only valuable to the designer in as much as they are assimilated into the process and affect the next stage of the work: in other words they need to be used by the architect and not presented to others. So I have discovered that there are times when I need to slow myself down, to prevent myself from being "efficient" and from producing.

But it is equally clear that there is a time for speed; for rushing from one software to another without trying to become proficient in any, for using them badly for purposes to which they were never intended. A time when you have to let the design pull you along wherever it goes, whether you feel ready to move with it or not.

And that is another way of describing the balancing act - the same one I started out hoping to find way to address. This thesis is only one step as I continue to develop my strategies and intuitions for this balancing act that is architecture today.
resources used
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Books

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Web pages/ e-mail
Architectural Design Process

Books

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Darke, J. (1979) The primary generator and the design process, Design Studies, 1(1), pp. 36 - 44.

Theater Design

Books

resources used: bibliography


Norton, E. (1978) *Broadway Down East: an informal account of the plays, players and playhouses of Boston from Puritan times to the present*. Public Library of the City of Boston


**Web pages**

www.paris.org/Monuments/opera/gifs/opera.garnier.htm


Theaters in Boston http://boston.sidewalk.com
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Software
The list of software I used in this project is extensive. Some of the programs were used extensively throughout the process, others only in a limited manner. I am extremely comfortable with some while others I use inexpertly to achieve limited goals.

Design development
Autodesk Mechanical Desktop 5.0
Autodesk AutoCAD 2000i
Kinetix 3D Studio MAX R3
MiniCAD VectorWorks 8.0
Quickslice V6.4
Rhinocerous 1.0
Teddy

Graphics/layout
Adobe Illustrator 9.0
Adobe Indesign 1.0
Adobe Photoshop 5.0
Microsoft Word 2000

Web Page
Macromedia Flash 4.0
Macromedia Dreamweaver 2.0

Hardware
Gateway E-5200 PC with pentium II
MicroScribe 3D form modeler -- digitizing arm
Universal X Class laser cutter
StrataSys FDM2000 -- fused deposition modeler
Olympus C3000 digital camera

resources used: hardware and software