The impact of CAD on the design process itself has to date been negligible. The vast majority of architects using information technology in the design of buildings have been either job-trained, viewing CAD as an optimization tool, or educated in academic programs where CAD is treated as a specialized subject, isolated from the core design studios and allowing for the perpetuation of manufacturing/systems-based ideologies which have changed very little over the last century. The tragedy is that this is happening while the design studios themselves explore vastly more complex and contemporary issues highlighted by the works of architecture's avant-garde. The result is a constant, pernicious repetition of arcane, industrial-age processes spilling over into information-age environments, constituting a misuse of the electronic medium; one that could offer the possibility of restating conceptual spatial exploration by its own definition and enabling students and by extension the profession to envision and test the design of the built environment from its most essential aspect, that of inhabitation. There is a synthetic chunk of universe at our fingertips where we can explore space not as an abstraction but as a phenomenological experience, allowing us to exercise our freedom to move and possibly regain our condition of Modernity.

Part I: Background

From High-Tech to Trans-Tech

As the presence of electronic media has become inevitably imbedded in our culture, it comes as no surprise that bits and pieces of this "high-technology" have become "transparent" to our senses. It is a wave of technology that has no tangible form or physical expression, permeating almost every aspect of our lives. Without an aspect of its own, it is the applications spawned by this state of technology that have become a visible phenomenon, such as ATM banking and CNN. Only with certain effort are we able to trace the effect back to the cause.

This state of technology, possessing an embodiment that has become invisible (or transparent) to us is what I will call Trans-Tech; an indicator of a third wave (Alvin Toffler) or post-industrial social and political environment. It identifies the transfer from a material-as-wealth to an information-as-wealth society, "where finance, communication, advertising and entertainment overshadow the political-economic human involvement in traditional 19th century Industrial Revolution era activities such as agriculture, manufacturing and transportation. Traditional principals of property, wealth, markets, capital and labor are no longer sufficient to describe or guide the dynamics of a modern, complex information society" (Benedikt).

The ideology of manufacturing based on prototype processes is representative of a passing epoch of Western Civilization. It has been displaced for the inevitable reason that these processes are no longer desirable sources of economic expansion, employment or political power. A case in point of this may be the end of the Cold War. The penetration of information based technology in the Eastern Bloc added a dynamic that the vintage techno-industrial Soviet system could not address. Based on strict hierarchies and linear political processes, the Warsaw Pact apparatus was literally bypassed by market driven political and economic forces, a logical consequence of uncontrollable, seamless access to information from the West. It is ironic that Post Industrial technology may have contributed to the demise of the greatest industrial Technocracy the world has ever known.

The replacement of wealth through manufactured goods (a linear "vertical" process), with abstract symbols such as combinations of binary interrupts (an open or "horizontal" process), enables a conceivable short-circuiting of traditional channels of political and economic power. This replaces traditional hierarchical order with an ad-hoc, self-
inventing non-order or heterarchical relationship as suggested by Lebbeus Woods in his monograph, “ANARCHITECTURE: Architecture is a Political Art.”

While the World as we know it is visibly being affected by the effects of transparent technologies, the use of information systems in architecture has had little or no impact in the way we design buildings. In reality, most architects who are actively using CAD in their practice still think, visualize and design on the same principals generated between the early Renaissance and WWII. These principals are procedure oriented, and find the benefits of designing on CAD to be mostly instrumental, not conceptual.

Architecture has historically been the tardy child of Western culture’s evolutionary shifts, and has yet to acknowledge emerging dynamics of change around us. To date, too many architects seem to harbor a neoromanticist contradiction such as striving to deconstruct the but by invoking Derrida but humbly rebuilding with a helping hand from planar geometry.

CAD: A Few Misconceptions

Those who are seriously incorporating CAD into their design processes are generally doing so by translating traditional architectural compositional strategies into CAD based operational terms. One example of this consists in developing architectural component libraries for insertion on 2D template systems. Notions such as generating 3D components that define “design kits” for repetitive, industrial-like assemblies only perpetuate a methodology of architectural design that predates our acquisition of alternative design environments. We must question their validity in enabling an architecture of this time.

We must also reconsider its usefulness in training young architects who have been educated in the age of information and who will probably redefine architecture as we know it. See figure 1.

This Industrial Age approach for incorporating CAD into the architectural process as a tool for simply optimizing traditional, paper based design techniques is stagnant and referenced to second wave, 19th century linear manufacturing processes. These are based on Hierarchical Order and Sequence, a curious contradiction to the current notion of Random Access.

Insisting on a hybrid, machine-age approach to CAD may be detrimental to the urban environment of the future, for one of the consequences of the popularization of CAD in the professional realm without redefining its purpose will be that more mediocre architects will be able to design more bad buildings. Conversely, more and more competent architects will turn to CAD for all the wrong reasons.

Figure 1: Traditional plan generated exercise using CAD as an instrument of manufacturing age processes.
From ACADIA, Summer 1991.

Significant architects of this century who have influenced the last couple of generations of academics and practitioners, based their work on an abstract and idealized spatial commentary; the idea of a generic disembodied movement through Space was a concept borrowed from painting, sculpture, and science as well as from the industrial manufacturing process itself. Idealizing the machine was an art form in its own right.

During this heroic modernist process of design through abstraction, the use of planar Euclidean geometry was at its heart. Two dimensional representational systems fulfilled its needs for a projectual environment. This methodology was an attempt to
bridge the chasm between three dimensional space and graphic representation, then limited to paper and scale models, a process that was born from and fostered by industrial age principals, and traditionally written off as being part of the foundations of Modern Architecture, such as the use of axonometric projections. However, these principals, born from the abstraction required to translate the qualities of space on to paper, now appear as inconsequential hold-overs of an analog past, that when "imported" into electronic space, result in perpetuating plan generated buildings with a common quality of being simply irrelevant architecture, a dark side of 20th Century modernism's legacy. See figures 2 and 3.

Emerging architectures of the last few years have demonstrated a patent preference for 3D models over abstract, two dimensional drawings. Many of these projects are conceived and designed as Space, relatively devoid of conventional geometrical abstraction as a conceptual departure point, and can hardly be described by two dimensional projections. The spaces described by these buildings are of a highly phenomenological, perceptual order that can only really be understood and acquire meaning when inhabited. This inhabitation is something very hard to achieve through scale model.

Architectural explorations and ideas such as those based on the spatiality of Chaos Theory, Strange Attractors, Subliminal Post-Structuralism, Heterarchical "Free-Space" and many others that so influence today's architecture students refer to alternative processes in generating Space. See figures 4 and 5. They suggest the design of an Information-age
Education and Practice: THE CRITICAL INTERFACE

architecture that is conceptually ahead of the obsolete industrial-age attitudes still surrounding the use of CAD. The widespread misconception of using CAD to mimic, automate and streamline what were originally manual, industrial-age processes have made its use unimportant to today’s avant-garde, and rightly so.

It is important to distinguish the space of an industrial society versus that of a post industrial one. First, we know or can describe many aspects of what constitutes the space born from machine-age processes, such as modularity, grid organization, sequence and linear hierarchies and the expression of industrial vocabulary (“high-tech” in some cases) as a cartoon like glorification of post WWII corporate iconography.

Second, while we don’t quite know how to define the space of a post industrial world (maybe because we are too close to it as trans-tech would have it), we may assume that its nature will be as different from industrial age space just as transparent technology is from high technology itself. The world of Trans Tech is so much more complex in so many ways compared to the abstract, sequential and repetitive Industrial order, that one must expect those complexities to be present in Trans-Tech’s definition of space and its generative processes. See figure 6.

Very few of today’s avant-garde architects are using CAD design environments at all. While they are striving towards ideas of architecture that are beyond the expressive capability of traditional design media, they demonstrate a limited, biased understanding of CAD precisely because of this image of seeing CAD as tied to arcane processes in which they have no interest whatsoever. Like many of their contemporaries, they have turned to electronic media only to make their ideas buildable, beyond the design phase.

Electronic Inhabitation: A True Time Machine

The premise in this interpretation of the relevance of CAD in the design process assumes that the most relevant condition in the design of the human environment is that of inhabitation, the physical, bodily occupation of its space. Traditionally, the only means for inhabiting the space of a building occurred when the project was actually built. Not until then were we able to move through its space, understand its scale and topography and learn of its relationship to our bodily presence.

When conceiving, designing and documenting a project of architecture, we are projecting, making a hypothesis, an educated guess about the actual perceptual outcome of the design. It is not until the building is materialized that we phenomenologically verify the characteristics and qualities we were pursuing, making our guesses more and more educated as our accumulation of built projects increases. No wonder that not until a considerable number of buildings have been materialized (and years gone by) that the architect has learned to factually visualize and convincingly pre-empt the perceptual, tangible real world consequences resulting from the design process. Perception and tangibility occur only in Space.

Space is a notion that, "is hard-wired into us from birth, and has the inherent quality of being defined by our freedom to move through it. Our awareness of this freedom is a phenomenological experience in itself." (Benedikt).

Cyberspace is an immaterial environment. In it Space is conceived, visualized and experienced, but is not really there. The same is true of our imagination when we are reading, say, a story from Italo Calvino’s Invisible Cities.

"Cyberspace inverts the relationship between humans and information, placing the human within the information space. It allows the literal placement of our bodies in spaces that were generated through our minds." (Marcos Novak).
If we accept that contemporary architectural exploration has its fundamental motivation in the need to address our senses, which exist only in Space, it would then seem a logical step for us to design in Space. Through the use of CAD and the invention of Cyberspace, we have discovered how to create our own space, one that possesses all the perceptual qualities of natural Space, allowing us to exercise our intuition freely, to exercise our freedom to move.

Our ability to generate full scale models and then inhabit them electronically through CAD constitutes a virtual time machine. It allows an approximation wherein individuals can experience the space of a design and perceive their presence at the scale of human visual and kinetic perception months, maybe years ahead of actual construction (if built at all). However, the great difference is that unlike the completed building, one can go back and change one's mind. This architectural "Quantum Leap" is an unprecedented addition to the design process and will become a relevant factor in its evolution by making us reevaluate the linkage between architectural concept and effect.

Part II: Methodology:
Towards an Architecture (Revisited)

The Education of a Third Wave Architect

In the academic context CAD has traditionally been treated as a subject unto itself, taught by instructors who “specialize” in the topic and targeted at students who have decided to concentrate in that specific area. This trend has generally drawn students with technology and programming backgrounds over those who see themselves as designers or all-around future practitioners, creating a technocratic subculture in many schools, and by extension, in the workplace. This may in part explain the shallow impact that CAD has had upon the design process itself, in schools as well as in the field. The actual progress in general design theory in the core design studios thus outgrows aging CAD methodologies still clinging onto establishment sanctioned precepts of architectural correctness, such as modular and component based design, a favorite of the old CAD establishment.

The question we must ask ourselves is what role can or should CAD play in the education of an architect as well as in exploring alternative visions in designing space. While many schools in this country are currently offering CAD as part of their undergraduate curriculum in some capacity, there seems to persist a division between CAD-specific studios and the core Building Design studios, largely because of the disdain of the design faculty and students towards the conservative and system-oriented (uncreative) image projected by many CAD-specific academic environments. The greatest problem in bringing CAD into the design process is this schism itself.

The reason for this may lay in the fact that while contemporary architectural exploration and its influence in the building design studio strives towards a whole new set of concerns (that by and large ignore or even contradict the premises on which traditional design methodologies are founded), CAD-studio instruction generally focuses on systematic processes with strong ties to traditional design methodologies, where the new medium actually becomes a restraint for exploring more provocative design concepts. It perpetuates the false idea that CAD is appropriate for repetition-intensive design, or for after the fact visualization.

An Alternative Method:
The Discovery of Inhabitation

The following is a proposal for incorporating CAD into the realm of the architectural design process. It focuses on using electronic space as a medium to create phenomenologically defined iterations in its development. The objective is to explore the redefinition of architectural design from the point of view of inhabitation (enabled by information technology such as CAD) as an alternative to traditional two dimensional/paper based processes, and expressly avoiding importing those methodologies into the electronic media, a widely practiced distortion of the relationship between design methodology and design environment.

At Woodbury University our approach towards integrating CAD into fourth and fifth year undergraduate design studios was defined by two complimentary states in conception, development, and definition of the design process.

The analytical state
The phenomenological state

The analytical state, or modelspace, refers to the need to address different levels of abstraction as a means of studying the many simultaneous issues that are
relevant to the design process. It is a state in which we analyze, take apart and then re-synthesize a design concept, studying aspects that belong to the realm of individual instances.

Urban scale and massing relationships, programmatic issues, functional diagrams, behavioral strategies, etc. are some of the conceptual layers or instances studied in Modelscape.

The purpose of working in Modelscape is to generate morphologically and dimensionally determinate 3D objects early in the design process. The fact that these models are dimensionally defined coincides with the fact that dimensions themselves are an abstraction.

Emphasis is placed on conveying the fact that the students are actually building a full scale model in Space, which we defined as chunk of universe, and that they are using a Cartesian coordinate system as a compass to enable them to navigate through this test-tube space. The monitor is described as the objective of an electronic camera through which one could peer into the chunk of universe. The apparent size of the model filling the screen is determined by the relative physical distance between the camera and the model itself. Any notion that one is looking at a drawing quickly disappears. For an architecture student, understanding the conceptual difference between a drawing and a model constitutes in itself a fundamental step forward in his or her education.

The fact is that their electronic alter-ego (camera) is at a very great distance (towards infinity) from the model. Thus, as viewed through the camera, it appears to be an underformed, axonometric implies, by definition, that all parallel lines of the model converge at a point situated infinitely away projection. Not so; in reality, it is a view of a model as seen through a very, very long telephoto lens located very, very far away. The apparent lack of deformation allows for measured operations on the model, thus defining Modelscape. See figure 7.

This electronic modeling process does not by any means replace any manual graphic explorations or modeling. On the contrary, the CAD component becomes a fundamental complement to the design process, enriching it and redefining the manual process itself. These CAD models are generated parallel to the first design sketches and are developed on a weekly basis, over ten weeks. Another important point is that a great deal of the CAD modeling, starting from schematics and thereafter, relies on solid modeling in combination with surface modeling. The former enables a more intuitive exercise of focal conceptualization on a otherwise intimidating over-precise environment, the latter allows the adventure.
of some level of detail, suggestive of an idea of vocabulary. See figure 8.

The Phenomenological state or Cyberspace, refers to the real, sensorial qualities of the spaces being developed during the design process. It is the discovery of the inhabitable space of their projects which constitutes the single most important attribute that students draw from employing a CAD environment in their design process.

From the beginning of the design process they are walking their electronic alter ego through a virtual world.

After several hours of cyberspatial experience, the monitor and even the user interface itself becomes transparent, leaving students alone in the space of their designs. The whole idea of being physically in and around a space resulting from a series of abstract concepts opens a range of creative opportunities. Principally and foremost, discovering the relationship between the space inside a dream and the space occupied by the body. It is these very personal discoveries that each of us makes which constitute the making of new, original thoughts about what constitutes architecture.

Like the protagonist in the film Terminator, who is able to travel in time to avert the doom of the future, the student working with a full scale cyberspatial model is able to inhabit the design of his or her conception while still in the conceptual stage of design, making inhabitation a decision-making factor in the design process.

Output was limited to sequenced cybershots printed on 8.5 x 11 laser prints taken at different levels of project development. Students soon understand the difference between an electronic photograph taken in cyberspace (cybershot), vs. a perspective. While a cybershot constitutes a piece of evidence as factual and experientially true as a still video image captured in realspace, a perspective is no more than a drawing, with no verifiable relationship to actually being there. See figure 9 and 10.

Cybershots are defined with hidden line wire frames, avoiding unnecessary graphics or rendering that might obscure the essential morphological and perceptual attributes being explored. By keeping the emphasis placed on the content of the images and not their sexiness, students avoid spending too much time on issues that are not related to essence of their design. This also means that their CAD time is kept within a desired proportion to their total studio time. This process pursues two objectives: understanding the properties of constructed space relative to the displacement of a bodily scale, and analyzing certain architectural qualities that can only be judged when inhabiting the space of a design. See figures 11-13.

Inhabitation Is Not Simulation

Students are not required to achieve a simulacrum of material realism. Simulation, as it is often seen, is nothing more than reconstruction of a space after the fact, with emphasis placed on an image for its own sake. The results are often voyeuristic and inconsequential to a student’s architectural education.

Figure 9 and 10: Left, The Phenomenological State, or Cyberspace. Regaining the freedom to move. Right, Perspective Drawing Method as described by Albrecht Durer, 1525.
The quality of the images typically depends not so much on the students themselves but on how sophisticated a visualization system their school can afford. These systems (such as Vrayfront) require more time in user training than any design studio student can invest. It is crucial that CAD not become an end in itself, obscuring the real issues at hand in the design studio.

In this case, students followed through the complete modeling and visualization process using Macintosh IIIs running Archicad 4.1, outputting to an Apple Laserwriter II. While this configuration seems quite pedestrian in all senses (and it was), it was sufficient to allow the modeling and cyberspatial inhabitation of the design studio’s exercises.

The process consisted in developing ongoing electronic models of their projects from day one through the completion of the building design studio.

The very first CAD massing models allowed for the inhabitation of the projects from their inception. At that stage, students reflected on such issues as human scale, the perceptual qualities of surfaces in space and over all, the discovery of depth in space. Later, the
models were reconstructed using only tentative structural systems as the sole Form Generators. Students unveiled the profound spatial capabilities that a structural system possesses as a form itself. This exercise brings to their attention the multiple qualities of space defined by different structural systems. These powerful cybershots of inhabited structures open a whole new perspective on the issue of structural design and architectural form. See figures 14-20.

Figure 14: Cybershot of space defined by structural system. 5th Year Studio. Student: Roy Dejesus. Instructor: G. Smulevich.

Figure 15: Cybershot of space defined by structural system. 5th Year Studio. Student: Michael Fernandez. Instructor: J. Garland and G. Smulevich.

Figure 16: Cybershot of space defined by real structure. 5th Year Studio. Student: Steven Gallegos. Instructor: J. Garland and G. Smulevich.

Figure 17: Cybershot of space defined by structural system. 5th Year Studio. Student: Allen Malleson. Instructor: J. Garland and G. Smulevich.
Figure 18: Cybershot of structural system related to urban design proposal. 5th Year Studio. Student: Alen Malekian. Instructors: J. Garland and C. Smulevitch.

Figures 19 and 20: Cybershots from within structural proposal. 5th Year Studio. Student: Steven Gallegos. Instructors: J. Garland and C. Smulevitch.
A final stage of development, in parallel to the studio project itself, introduces more elements of the students' architectural vocabulary. Certain details, exterior treatments and other slightly more refined modeling elements are introduced as they became essential to reinforcing the sense of inhabitation of the projects' spaces.

Working with different levels of model completion provided a true pedagogical approach to understanding the diverse aspects that define architectural form and space. Students were asked to furnish analytical views of their projects as well as sequenced cybershots from the spaces within. Thus the abstract and the phenomenological were used side by side in studying the projects.

Concepts such as massing, structure, axiality (all kinds) and layering, all of them addressable with traditional models and drawings acquired a different level of discourse through cyberspatial inhabitation. Once the students were introduced to the perceptual qualities of space, even at a simple massing level, interesting improvements began to enrich their design processes.
Results

First, students demonstrated a better understanding of traditional basic architectural concepts, such as those mentioned above. The difference was that they transcended the status quo, their academic generalization. These concepts became real, tangible effects of the senses.

Second, students stopped generating architectural forms based on the finite variations of the proverbial Box, a crude paradigm of a generalized shape so harmful to any true exploration of project-specific space. Once students discovered that designing from the outside-in and inside-out could in fact be a seamless continuum, the need for artificially delimiting space with preconceived, generalized parts (boxes) became superficial and unimportant. This may explain why the projects developed in these studios were so personal and unique to each individual student. See figures 22-25.

Third, most students become much more sophisticated and complex about their work than

Figure 22: Inhabitation of exterior space, integrating the ground plane as a space-generating form. Student: Eric Hammerlund. Instructor: G. Smulevich.

Figure 23: Cyberhot studying depth of space. Student: Eric Hammerlund. Instructor: G. Smulevich.
they were before being introduced to electronic inhabitation. Having only a prior five week introductory course to the particular CAD platform as part of their second year curriculum, they did not have the kind of dependence on the system that would have enslaved them to it, placing the medium before the substance. This economy of means in hardware and focused CAD training helped keep the medium in the appropriate perspective relative to the content of the design studio itself.
Conclusion: Toward an Architecture (Revisited)

Architecture is an exercise of accumulated experience and the talent to draw on that experience to create space. The infinite wealth of technological and cultural information that enables professional competence requires many years of hard work and the tenacity (and fortune) to see that work materialized.

Otto Wagner remarked in Modern Architecture, 1896: "Surely it is no exaggeration to place the successful practice of the architect beyond the fortieth year". We may take note that the average life expectancy in Europe at the time was 42.5 years. A short time to enjoy one’s success. Perhaps the most enlightening lessons to be learned from this layering of experience is to be found in the experience of space itself. This act of inhabitation occurred when the architect was able to walk his or her own materialized designs. It depended on seeing dozens of buildings completed over many years, allowing one to learn by trial and error. It was only then that so many analytical and abstract concepts and ideas, acquired through a protracted education, were either verified or vilified. To help us pre-empt the outcome of these built experiences, we used both artifice and imagination, and we built models.

However, the only way we could possibly experience the space of our designs in a manner that would satisfy the conditions of inhabitation (other than the built product) would be to fabricate a full scale model, one that would allow us to enter it and move through it.

This is precisely what we have achieved with the use of CAD and the creation of the Cyberspace.

The evolution of the architectural design process, from designing based on abstract analysis and materialized trial and error, to incorporating an electronic phenomenological experience (through
cyberspace) as a fundamental condition for design, will create a series of interesting changes in the way we exercise the profession of architecture.

First, it will to some degree break Wagner's forty year learning curve by allowing architects to experience the space of their designs whether these get built or not. This suggests the development of more experienced, self-assured architects at an earlier age than ever seen in history. Many more people will be taking more and greater chances with their work, testing and experimenting personal approaches in design, once they can focus on being creative without the anxiety (and frustration) of waiting to see the built results. The variety in design solutions and architectural vocabulary will become more and more diverse as individual designers are able to unshackle themselves from manufacturing age dogmas and become operators of their senses, much in the way other artists have done for ages. Maybe then architecture will become an initiator of change, as in the case of other art forms.

Talking about the architects of the future, Lebbeus Woods wrote in Architecture is a Political Act: "The architect is not, in this case, a detached professional, upholding timeless values, but an instigator, an agitator, an active participant. One does not participate by following the cries of change, but by being part of its initiation."

Second, this process will affect the way we teach architecture, long before it actually affects the profession itself. To teach today's students to understand the profound phenomenological consequences of designing for human inhabitation makes sense for a generation weaned on MTV. The influence of electronic visual media has long overflowed from its tradition channels, permeating politics and the arts. This generation of future architects has received its cultural exposure from experiencing (almost exclusively) electronic visual images rather than reading books. If this is their language, then they should master it. So should their instructors.

Third, and speaking about the studio instructors, we would be fooling ourselves by segregating the teaching of CAD from traditional design studios. With CAD and cyberspace, as a medium and environment, we must understand and be proficient in the principals of electronic inhabitation. In our position as mediators between our historical heritage and the conditions of a changing world, it is our responsibility to clarify and explore with our students the synthesis between our past and our future, a dynamic relationship that shifts and re-invents its terms at an increasing pace, as does technology itself.

Finally, it is important to point out that the instructors involved in these fourth and fifth year building design studios possessed only a minimal knowledge of the specific CAD software being used. If anything, this may prove that it will not necessarily be systems expertise or CAD wizardry that will be the decisive factor in educating the next generation of architects; rather, it will be open minds and unprepared inquisitive attitudes that will be influential in guiding them towards a new architecture; minds that feel at home both in Poiyso as well as in The Matrix.

References


