FORM, COLOR & MOVEMENT

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ABSTRACT

Computer generated three dimensional architectural modeling is a fundamental transformation of the traditional architectural design process.

Viewing a three dimensional computer model from many vantage points and through animation sequences, presents buildings and their surrounding environments as a sequence of spaces and events, rather than as static objects or graphic abstractions. Three dimensional modeling at the earliest stages of design tends to increase the spatial and formal properties of early building design studies, and diminishes the dominance of plan as the form giver.

The following paper is based upon the work of second, third and fifth year architectural students who have engaged in architectural design through the use of microcomputer graphics. In each case they entered the architectural studio with virtually no computer experience. Although the assigned architectural projects were identical to those of other "conventional" architectural studios, their design work was accomplished, almost solely, using four different types of graphic software: Computer-Aided Drafting, 3-Dimensional Modeling, Painting and Animation programs. Information presented is based upon student surveys, semester logs, interviews, impressions of external design critics, and the comparison of computer based and conventional studio final presentations.

CONCEPT AND DESIGN

Undertaking traditional architectural design solely through the use of color 3-D modeling software has as great an influence upon the design process, and the understanding of a proposed design, as the new architectural simulations it produces. However, based upon our experiences of using the computer directly in the architectural studio, many first assumptions about computer-aided graphics (i.e. conceptually limiting, leading to rigid or repetitive designs, graphically uninspired, etc.) have to be inaccurate. It is clearly possible and advantageous to utilize computer modeling and graphics as the fundamental method for creating, viewing, evaluating and presenting architectural
designs within the academic studio context. Although software dependant, the computer model is perfectly suited for the creation of early three dimensional massing studies, evaluating groups of buildings, and for the study of alternative building concepts. Although the computer model is seemingly more abstract, (stored on disk and not in "tangible" piles of yellow tracing paper, viewable only on the screen and not touchable), the three-dimensional model actually engages the students as a more realistic entity present than many other forms of architectural illustration. If for no other reason than the fact that input requires information in an x/y/z coordinate system, students automatically think and react to three-dimensional relationships. As in the case with chipboard model building, once involved in the creation of a three-dimensional model, the "reality" of the space engages the designer's interest and generates substantially more development of architectural design concepts.

Rather than mask the individuality of design work, the dynamics of computer systems encourage a greater variety of design concepts, than in the customary design studio. Having undertaken numerous architectural projects with both computer and non-computer based design, we have found as much variety of form, concept, site organization and imagery with computer based designs as non-computer based student designs.

When using conventional design media, the critic is often faced with having to artificially require design alternatives. Usually the student approaches this work with little enthusiasm, viewing it as an academic exercise. Using menu driven 3-D modeling, students do not hesitate to create numerous and varied architectural forms. In the beginning, the ability to design what can not be drawn encourages the widest variety of unusual forms and architectural compositions, even when inappropriate. Regrettably, the ability to quickly and easily develop alternative designs permits beginning students to remain in the conceptual design stage for excessive periods of time, as they explore endless variations.

Advanced architectural students may work in a conventional manner, bringing pre-formed concepts to the computer model for presentation, if left to their own design process. They tend to rely on the computer to present design decisions already made, rather than directly use the computer as a design tool. It is preferable for students to engage in initial computer/design studies which define the boundaries, limitations and advantages of the particular software system. Once this is accomplished architectural design can begin on the computer screen.

ARCHITECTURAL FORM

The use of repetitive rectilinear elements, rotations, symmetries, etc. are more prevalent in the computer based architectural models than the conventional studio, because of the
inherent capabilities and command structure of CAD/Graphics systems. Students generally seek to unify complex functional programs into repetitive units of similar physical characteristics.

The geometric nature of the software naturally illustrates "basic design" concepts, and increases the students desire to explore patterns, symmetries or other ordering principles. In many cases, the interest in formal organization is at the expense of functional requirements or relationships.

Designers who have a strong tendency to hierarchy, transformation, axis, symmetries, etc. find the computer system a productive and manageable media. Those designers with a lesser ability in abstract thinking find it virtually impossible to use the computer directly as the primary design tool. Making a detailed conventional architectural plan is quite difficult. (In fact, drawing a two-dimensional representation requires a conscious effort to eliminate the third dimension.) The associated bit mapped graphics program (paint capability) can be both the most seductive of the graphic software packages, and ultimately the most unmanageable design tool for the weaker design student. The most ineffective use of this graphic system results when one attempts to utilize the paint software solely as a pictorial tool. Whether sketching free hand, or using the wide variety of graphic commands, designs originated in "paint" systems are extremely difficult to develop further. Although "sketching" with the computer, the system does not provide the same hand-eye relationship, or "visual reading" as traditional soft pencil on yellow sketch paper. As a result weaker students generally do not develop in their ability to think abstractly as a result of "paint" systems design.

CONCEPT AND SKETCH

A three dimensional computer model is not easily utilized as a "thinking" tool. Unless a student comes to the computer with a very specific design goal and conceptual notion, most designers return to small sketches when developing the earliest concept or idea. Therefore sketch books and yellow tracing paper are a fundamental part of a computer based studio. Their presence is even more apparent because all other "drawings" can be accomplished with the computer model. What tends to be missing from the studio process is the parallel ruled orthographic and axonometric drawings. Added to the early design process are three dimensional models, with limitless perspective views. These are in themselves a new form of concept drawing. Surprisingly, in the beginning stages of design, many students prefer the non-hidden three dimensional images to those which have hidden lines removed or have been "painted." Because of their graphic ambiguity, the non-hidden drawing more closely approximates the abstract, small scale freehand sketch or "architectural doodle." Students are able to discover or "read
into" the drawing new design concepts or relationships. This level of interaction between designer and computer does not seem to be as apparent when one uses conventional drafting software.

The understanding of the built environment, the mechanisms which give it form, the concepts and theories by which it is created, and the development of personal design philosophies has a long history of sketches and notes made both in the field and in the studio. The computer model does not automatically close the gap between thought and graphic representation. It is probable that one freehand sketch is remembered far longer and more accurately than a series of computer images. Therefore, the summation of freehand visual notes and sketches may continue to provide the fundamental basis for the development of ones mental library of architectural ideas, and remembered experiences. However, the dynamics of simplified animation, which is now available on even the simplest computer system, does open a totally new means for visualizing, understanding and remembering proposed architectural places.

Rather than proceeding in a fragmented manner from freehand sketch, to plan/section drawings, to axonometric, the computer permits, within one model, the immediate illustration of a design in three dimensions. If a student is able to systematically develop this early computer model to a more advanced level, the loss of "original intent or concept" is minimized. This minimizes the subtle changes in form and meaning that often occurs when one moves directly from small freehand sketch to drafted plan.

DESIGN ALTERNATIVES

In the traditional studio, students have many ideas about their design but usually focus upon one solution. In a computer based studio, it is possible for designers to develop numerous building designs without a clear understanding of their relative advantage or disadvantage. The easy and somewhat impersonal means of creating design alternatives with the computer, often frees the weaker student from dogmatic allegiance to a bad idea or decision.

Often the primary advantage of computer modeling is considered to be the representation of complex drawings. At the early stages of design, computer graphics systems are just as powerful in their creation of three dimensional models as the CAD systems are powerful in their ability to draw, and other computer programs in their ability to analyze. One studio afternoon can bring a student through the development of dozens of design alternatives. Rather than ask the student to work on another approach and present it tomorrow, students can develop alternatives immediately and interactively with the studio critic or fellow student. Interactive design between critic, student and computer can increase the amount of time the critic spends with each
student during the course of an afternoon. The
idea/design/evaluate cycle increases by many fold. This
increases the students need understand the direction in which
they are heading. Within a few computer commands, a design can
be radically transformed into a completely different concept
resulting in an entirely different type of building. For the
beginning students, whose relationship between design intend and
product is often unclear or confused, the computers abilities to
easily "do anything" can be detrimental. Transformation of a
design can easily proceed thought.

COMPUTER MODEL

At first glance the computer appears to be a perspective machine.
However, the computer model is fundamentally different than paper
representations or study models. First, the computer model is a
"whole," not divided into numerous scales of site, building or
detail. Students often rely excessively on plan and elevation,
frequently with little study in section, and fewer spatial design
studies. The computer's three dimensional model results in an
opposite emphasis. The architectural plan becomes the least
studied. The computer model diminishes the fragmentation in
thinking as one moves from site, to building, to detail within
one architectural model.

Secondly, the computer model is "walkable," being able to be
viewed from many sequential vantage points. The vast number of
views from eye level, even when relatively simple in detail,
overcome the limitations of customary drawings, more closely
simulating the real world experience. In fact, experiencing a
series of walk through vignettes can present a building more
realistically than conventional drawing. The sense of "being
there" is increased, even beyond the impression given by standard
study models (which are inevitably viewed and judged from above
or from non-realistic vantage points, and dominantly from the
exterior).

The sense of scale and proportion is considered from eye level
views, rather than through axonometric drawings, or through the
introduction of scale figures in elevation. At one time, a
student could only design what they could draw, even though their
ideas may exceed their graphic ability. If they could not
quickly and easily draw in three dimensions, their building were
the assembly of plans stacked one upon the other. The computer
model can develop spatial models with relative ease, and can
illustrate these designs in a realistic manner.

43
The study of color in architecture, often ignored in design studio or dealt with in a minimal manner, can be easily integrated into the design curriculum. Students are able to create, evaluate and propose a variety of detailed designs which consider color as a fundamental property of the built environment. Students evaluate different color schemes as they adjust different pallets of color and view different color schemes instantly, without having to redraw the design (pallet is 16 colors from 262,000). Varying red, green and blue, each in 64 increments, while viewing the image permits the interactive study of color directly in the architectural context. Rather than adjust color through the choice of paper swatches, pencil colors, or ink washes, one can instantly change the entire color pallet of an image. (A discussion of color theory in a computer studio now is in terms of red-green-blue instead of the primary colors of red-yellow-blue.) As a result we have found that color is not only considered a rendering technique, but also fundamental means for expressing the character of a building.

When color is "always part of the design" additional questions become apparent that requires answers from students. What material or technology can provide the desired colors or textures? To what degree is the quality of the design a result of its color and color composition?

As one applies color and "pixel graphics" to a computer model, the design process leads away from the "technical" aspects of architecture into the arena of illustration. On the other hand, traditional CADD software tends to lead the design process into technical or abstract development, sometimes prematurely.

The ability to be present a design in a variety of ways including wire frame, hidden line, color surfaces and "bit mapped" painted images, is an important set of capabilities for the design process. Each type of representation has unique attributes and assists in the development of different design characteristics. Single systems which represent only wire frame, surface, solid models, or bit mapped images quickly seem restrictive.

In part because of the vast number of views experienced, their full color rendition and the interaction with a unified architectural model over an extended period of time, students speak less of their work as drawings, diagrams or ideas, and then discuss the characteristics of their buildings as they have experienced it. Because three dimensional models can quickly be created and transformed into the color and animation media, it is possible to dramatically shorten the time between initial concept and the production of images at the refined level of final presentation. The fascination with this "instant product" can encourage students create numerous rendering and walk-through sequences without structural, mechanical and construction development. However, it is a design which the
students (and critics) have seen from "virtually every vantage point", with a far more developed understanding of the design as building.

**MOVEMENT**

Simplified animation sequences through a proposed design addresses questions often discussed in the design studio, but rarely experienced or carefully studied. Choosing a path through a design, with specific vantage points, focal points of interest, and the associated story being told, presents a proposed design as a "movement dependant place" (maybe as real as the Saturday morning cartoon world). This type of presentation more closely simulates the building as it will be experienced, although in a "non-traditional architectonic" vocabulary. Spaces are not discussed based upon what they might or will be like, but rather on how they are shown and moved through. The progression from open to enclosed, high to low, inside to outside is experienced, discussed and modified. Often the critic asks the student to "walk through their design in their minds eye." The minds eye is now supplemented by computer animation. The dynamic relationships of movement, path, destination, focal point, sequence, variety, etc. are more easily experienced and discussed. Most importantly the sense of how large a space or building is can be experienced, judged and interactively changed.

Simple animation sequences takes architectural design into a more understandable world, rather than the more abstract world usually associated with the computer.

**MODIFYING THE DESIGN METHOD & PRODUCT**

The computer model has a number of attributes which can change the design process. One can start to design be assembling pre-existing parts, from realistic objects to geometric constructs. The first representation of a design can include a level of visual detail not available through conventional means, utilizing a simple library of three dimensional components (columns, furnishings, windows, etc.), to complete pre-existing 3-D building models (building type precedents). When using the computer, the simplest room has the potential to include elaborate furnishings, wall textures, color, or other details selected from preexisting libraries. The computer model can simulate "play-block" building, as a student places electronic blocks or building elements together to create architectural form. Regrettably, if designs are first developed from a library of detailed objects they may be accepted because of their visual detail rather than architectural quality. Illustrations which look complete tend to be valued more easily than those under development. Also, the computer gives students the ability to easily create finished presentations of incomplete or ill-considered concepts.
One of the clearest changes in the process/product relationship is the virtual elimination of intermediate presentations. Every stage, every alternative, of the design is immediately available as "presentation" and can have identical visual quality. Without external review, the design process can proceed uninterrupted without points of review or analysis. This, of course, is not necessarily an advantage. The various stages of design are more easily masked by the computer system. Because of the rapid change and updating of a building model, often there are few records kept. There is no pile of yellow sketch paper on the floor. A handful of computer files are more difficult to review quickly than a stack of pencil sketches. Therefore the evolution of design may be more obscure in the computer based studio than with conventional media. Again, this can be confusing to a designer who has not developed a clear direction or design philosophy.

We have not found that computer based studio is "paperless." Our students placed small drawing tables next to the computer. Sketching over dot-matrix prints from the computer or over the computer screen itself, students work interactively between computer model and conceptual sketch. Freehand sketches are also found on the computer's digitizer, as "soft-pencil" ideas directly become computer model.

The final product is only a portion of the design as it is stored within the computer, and as it is understood by the student. Rather than the final presentation being the totality of the design (all information known and considered), the final presentation is only a selection of a representative sample of the entire design. Guest critics can be frustrated by students referring to other views that are "in the computer," rather than on display before them. To thoroughly review a completed project involves substantially more time than in a conventional studio as there is more to see, and typically more work developed along they way. Students quickly prefer to include dozens of views or animations, all of which are three dimensional, rather than plan, section, and elevation drawings.

Student work which is presented at the level of wireframe or hidden line 3-D model are graphically uniform. Typically design review discussions speak much less of graphics per se, and focus upon design concept or intent. Unfortunately, this ease of producing automatic presentation drawings may diminish the students desire to learn and practice the necessary skills of making fine drawings.

CONCLUSION

It is the impact of the new media upon the way we view, model and evaluate our architectural world that may change architecture and architectural education. Because computer graphics adds new, varied and extremely powerful tools to the design process, and
permits the modeling of architecture in fundamentally new ways, it is a capability which should be integrated into the mainstream of studio education. As any new tool or language, its value to a student only becomes clear when used in a productive design context, not merely when studied as an academic exercise of commands, files, structures, etc.

Because any CAD or graphics systems have either implicit or explicit methods for creating architectural images, they directly effect the fundamental nature or theory of architectural design. As computer graphics move into levels of illustration which exceed what can be accomplished manually, (rather than simply provide fast solutions for traditional work), the question of their influence upon architectural design and buildings themselves will increase.

The computer clearly allows for design exploration in ways that are not possible with traditional media, and at a speed which has a direct influence upon quality of concept and product. Computer modeling, with all its variety, has the potential to enhance the speculative and imaginative aspects of architectural design.
Images from 3-D Microcomputer Models

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