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A Proposal for Alternative Methods for Teaching Digital Design

Computers have the potential to radically change the process of architectural design, and match more closely the formal aspirations of contemporary designers. What, then, should be the direction educators take in response to the opportunities created by the use of computers in the design process? There are, perhaps, two obvious methods of teaching Digital Design at a university level; a course adjunct to a design studio, or a course offered independently of a design studio.

The computer is a facilitator of design ideas, but by itself, is not a creator of content. The primary responsibility of the design studio is the creation of content. It is the implementation of theory and critical analysis which should be the core concern of studio instruction. Given the limited time students are exposed to design studio it would seem appropriate, then, that the digital tools, which facilitate the design process, be taught separately, so as not to dilute the design studios importance. Likewise, this separation should allow the student to concentrate attention on Digital Design as a comprehensive process, beginning with initial massing studies and ending with high resolution presentation drawings. The burden of learning this new process is difficult as well as time consuming. Students are generally struggling to learn how to design, much less to design on the computer. In addition, the current lack of digital skills on the part of design faculty makes it difficult to create a level of consistency in teaching digital design. Compounding these problems is the cost to architectural departments of providing hardware and software resources sufficient to have a computer on every studio desk.

Une proposition de méthodologies alternatives pour l'enseignement du design digital

Depuis des siècles les architectes ont utilisé le plan et l'élévation comme outils primaires lors de conception. La nature abstraite et deux-dimensionelle fait partie intégrale de l'usage de ces outils, mais les architectes, par définition, participent à la construction d'une forme trois-dimensionnelle. L'architecture moderne au début du vingtième siècle est devenue de plus en plus trois-dimensionnelle de nature. Nous nous trouvons maintenant dans une position ou les outils de création de conviennent plus aux méthodes de conception.

L'ordinateur facilite le processus de conception, mais en soi ne crée pas le contenu des idées. La responsabilité première du studio de design est la création de ce contenu. L'implantation de la théorie et de l'analyse critique devraient être le focus de l'instruction en studio. Étant donné le temps limité durant lequel les étudiants se trouvent en studio de design, il serait alors bon que les méthodes digitales servant à faciliter le processus de conception soient enseignées séparément, pour ne pas diluer l'importance du studio de design. De même, cette séparation permettrait à l'étudiant de se concentrer sur les méthodes électroniques de conception en tant que processus compréhensif, débutant avec études de masse, et terminant avec des dessins de présentation à haute résolution. Cette apprentissage est une tâche longue et difficile. Les étudiants ont généralement assez à apprendre le design, sans parler du design sur ordinateur. De plus, la présente manque de connaissances sur les méthodes de conception par ordinateur de la part des professeurs, fait qu'il est difficile d'atteindre un niveau consistent lors de l'enseignement du design digital. A ces problèmes s'ajoute le coût pour les départements d'architecture de fournir des ressources suffisantes à l'emplacement d'un ordinateur sur chaque bureau du studio.

introduction

For centuries architects have used plan and elevation as their primary direct design tools. Inherent in the use of these tools is their two dimensional abstract nature, yet architects by definition are involved in the creation of 3D built form. To mitigate this, the architect might gravitate to perspective drawing or physical modeling. This will generally occur later in the process, and the amount of time and effort involved in the set up and manipulation of these tools generally have made them crude methods for architects to design with. There has been a deep conflict between the tools of creation and the final object of creation. This has served as a severe, yet traditionally accepted, limitation in the architectural design process. Indeed, over the centuries there has developed an almost cult status, in architecture, for the drawing, wherein drawings have more value, as opportunities for creative expression, to the designer than the building itself. One might question whether these architects are really painters. Classical and Neoclassical architectural design by architects almost exclusively concentrated on facadism and proportional dynamics, and, in this sense the two dimensional tools available fit the mode of design. Modern architecture from the beginning of the Twentieth Century has increasing become more 3D in nature; from Mendelsohn's Einstein Tower (1920) to Corbusier's Ronchamp Chapel (1950), to Frank Gehry's museum at Bilbao (1997). Imagine trying to understand these structures using only plans and elevations. We now find ourselves in a position where the tools of creation no longer adequately match the mode of design.

digital architectural design

Computers have the potential to radically change the process of architectural design, and match more closely the formal aspirations of contemporary designers. To address these issues, this paper begins with several propositions:

1. Digital-based design will replace traditional modes of architectural design.
2. Students must learn to design "on screen", initially without hand sketching.
3. Instruction should be "Creatively-based" rather than "Skill-based."
4. Instruction should be taught independently of design studio courses.
5. Instruction should be comprehensive, beginning with initial massing studies and finishing with high resolution graphics.
6. Digital-based graphic design will raise expectations for presentation quality, both in terms of content and imagery.

Digital design is a process in which design decisions are made "on screen" rather than with sketch paper. The design evolves from the earliest possible stages in a 3D digital format, and remains digital throughout the design process. Often even preliminary hand sketching is not necessary. The 3D model can serve as the basis for contract documents due to its easy transition into AutoCad. This has proven cost effective especially with complex and curving forms. In most cases this process is quicker and more accurate than a non-digital process. Digital design gives the architect the ability to design in a highly effective simulated 3D environment, one that allows the designer to predict the quality of their efforts, within a time frame much more consummate to their thought process. The 3D nature of these tools invite the designer to think and act in the third dimension to a greater degree than previously imagined, and is less reliant on the architect's raw power of 3D imagination. At any point in the design process an updated 3D image can be available for evaluation. In addition the complexity of shapes that can be quickly described is much more extensive than with traditional tools. The ability to predict and present a formal idea is enhanced by a digital-based process, this is due to the ability of the software available today to provide photorealistic rendering at a much earlier point in the designer's process.

The hardware and software available today have the speed, and intuitive interface which make direct "on screen" design of buildings not only possible but preferable over traditional methods. Digital design solves one of the major restrictions of all traditional processes, in that all of the elements are editable. From simple initial massing models to final renderings, all elements can be easily changed and manipulated. Changes in design using traditional methods require the rebuilding of models or the redrawing of perspective views. In a digital design process, changes can

be undone and redone, saved, then altered,then saved again, only to return to the original idea.

In the last two years digital design has begun to find its place within the architectural profession. The essence of this process is that the computer is used as a design tool, directly by the project designer and team, rather than a post design rendering and presentation tool. This distinction is important, watercolor, for example, can make a presentation poetic if created with talent and care, but adds little to the design process itself, other than a painterly quality to an initial sketch. The digital design process has an appeal to clients, who, in the experience of the author, have an strong desire for realistic images of their project during the earliest stages of design, rather than waiting until the design is almost finished. This is critical to the success of a design process. The clearer an understanding a client has of the design, the more confident they can be that the design decisions being made are the right decisions.

digital-based graphic design

In addition to architectural design, changes are taking place in other fields which deserve our attention. Graphic design is one such field. It is important to understand how digital presentation can be a creator of meaning that goes beyond the traditional and simple use of plan, elevation, and perspective. Previously architects were restricted, by what they could reasonably draw by hand, in their evaluation of the level of content they could provide in a given presentation. Generally this meant that the type of drawings considered were limited to plans, elevations, axonometrics, and perspective, with the addition of only the most modest amounts of text, usually a drawing and sheet title. The computer has changed this in many ways.

Most architectural designs are based upon concepts that can generally be expressed with words and images beyond that of the building design itself. Digitally-based graphic design allows for a complex and rich format with which to express these ideas. Graphic design is the use of imagery and text to create meaning in an organized and clear fashion. It can include the use of symbolism, metaphor, and comparison. It can use imagery that shows context, design process, and

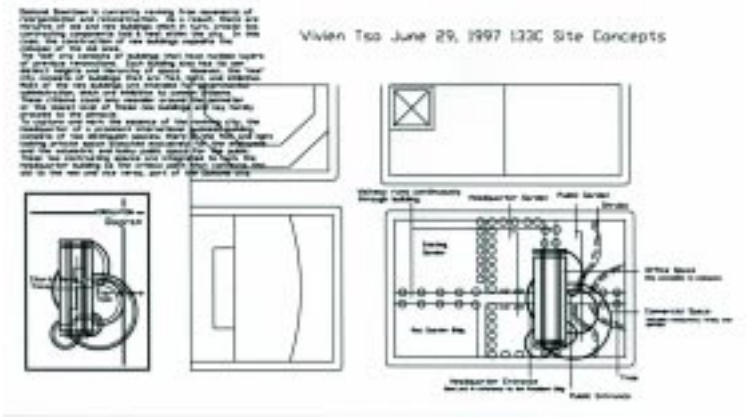

Figure1a. Site sketch, by Vivian Tso.

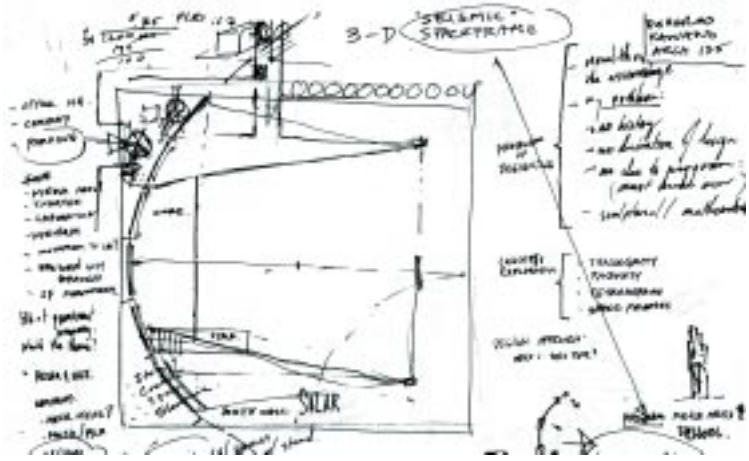

Figure1b. Site sketch, by Douglas Kawano.

can make obvious relationships and the ideas that connect them. Traditionally architects have rarely gone beyond the simplicity of Renaissance painting for their graphic concepts. One image per area, that was generally self contained with in the frame. Digital-based graphic design allows the architect to begin to collage ideas, show relationships and build visual concepts.

This is a result of the ability of image editing programs to allow an almost infinite number of independent layers of imagery and text. These layers can be moved and manipulated without affecting other layers, and can be edited in a number of ways, always preserving the ability to change back to a previous version. The images that can be used in a presentation has been expanded as well, they can come from a variety of sources, including photographic, historical, contextual, or hand sketched to name a few. If a student's design is based upon the relationship of buildings with the automobile, for example, the student can take photographs of existing relationships and include these as part of the presentation. Traditionally the time to have hand drawn these same images, and then to have the option to change their placement on the final presentation boards would have made their inclusion unreasonable. In addition to imagery, the inclusion of text in a presentation has changed as well. Traditionally text is used sparingly in student presentations, this is due to the difficulty in both physically placing the text, and in editing the text once placed. Text can now be placed and changed digitally, quickly and almost effortlessly. This allows text to be used in two new ways, one, longer narratives can be included than previously anticipated, and two, text can be used as a significant graphic design element itself.

Easing the limitations of time and editability that have plagued architectural presentations in the past, now allow the introduction of graphic design into the presentation of architectural ideas. The current conventional wisdom holds that the computer is best at creating "slick imagery," but, this viewpoint ignores the fundamental strengths of graphic design. It is our responsibility as educators to insure that students look beneath the "slick" surface and grasp the conceptual depth digital-based graphic design can provide.

Although digital-based architectural and graphic design have clear methodological advantages over the traditional process, it has been slow to find widespread acceptance within the architectural profession. This is not the case in other professions such as graphic design, which has overwhelmingly embraced digital design, at least in the San Francisco Bay area. This reluctance of architects is due, in part, to the painterly traditions of architecture, as well as, the age level of its senior designers. The relatively long learning curve of digital design has had a dampening effect on its acceptance with older designers. In addition, the imagery that computers have had the capacity to produce has, until recently, not been of a quality, both in terms of resolution and esthetics, to invite the interest of designers. This has now changed, computers have the capacity to create imagery that equals if not exceeds that of traditional media, and this has finally caught the interest of decisionmaking designers. It is not naive to expect that, in the foreseeable future, most design will be digitally-based. At Kaplan McLaughlin Diaz in San Francisco, for example, young designers are not considered for interviews without compelling 3D software examples in their portfolios.

alternative teaching methodologies

What, then, should be the direction educators take in response to the opportunities created by the use of computers in the design process? There are, perhaps, two obvious methods of teaching digital design at a university level; a course adjunct to a design studio, or a course offered independently of a design studio. In a way, this is perhaps the classic, chicken or the egg paradox. Should the student learn this process during and perhaps in conflict with, a design studio; or should a course be created that will concentrate on learning how to design "on a computer," with the emphasis on learning a new process rather than learning how to design.

The computer is a facilitator of design ideas, but by itself, is not a creator of content. The primary responsibility of the design studio is the creation of content. It is the implementation of theory and critical analysis which should be the core concern of studio instruction. Given the limited time students are exposed to design studio it would seem

appropriate, then, that the digital tools, which facilitate the design process, be taught separately, so as not to dilute the design studios importance. Like wise, this separation should allow the student to concentrate attention on digital design as a comprehensive process, beginning with initial massing studies and ending with high resolution presentation drawings. The burden of learning this new process is difficult as well as time consuming. Students are generally struggling to learn how to design, much less to design on the computer. In addition, the current lack of digital skills on the part of design faculty makes it difficult to create a level of consistency in teaching digital design. Compounding these problems is the cost to architectural departments of providing hardware and software resources sufficient to have a computer on every studio desk.

This paper, then, takes the position that the process of designing digitally should initially taught separately for the design studio. After this initial course, it is critical that the design studios reinforce this training. Studio design instructors, while not necessarily experts in hardware and software, should understand its potentials and limitations. Their demands for students to design and present clearly and deeply should not diminish, but rather increase, with the welcoming of the computer into the design studio.

At the University of California at Berkeley we have developed a course which teaches the process of digital design as an endeavor independent of the design studio: *Arch 135, Digital Design: Process and Methods of Modeling and Presentation*. This course has set six basic pedagogical goals:

1. To teach students to design “on screen”, as an alternative to the traditional plan and elevation process. To understand the value of a digital-based evaluation and prediction process.
2. To encourage students to design more in 3D, using a variety of complex, organic and / or compound curve-based shapes.
3. To encourage students to use digital design in their studio courses.
4. To teach students a comprehensive digital design process. One beginning with initial massing studies and ending with high resolution presentation drawings.
5. To expose students to the image making opportunities of realistic rendering techniques.
6. To expose students to the opportunities of graphic design via the computer, and to explore presentation methodologies beyond the painterly approaches of architectural tradition

creative vs. skill-based approaches

One fundamental premise of this course is that, digital design is a creative process. As such, it should be taught using a design project as a vehicle to teach this process. This "creative process" approach is different than a "skill-based" approach. A "skill-based" approach might concentrate on building 3D skills through a series of incremental exercises, starting with basic blocks, leading to more complex shapes, ending with a predetermined simple building, or at its most adventuresome, the modeling of an existing building by a famous architect. This is much like the tutorial that is provided by the software maker. At worst, the “skill-based” approach reinforces the idea that computers are best used as “post design” modeling and rendering tools, and not the vital "direct design" process facilitation tool it can be. At best, the "skill-based" approach should be challenged on how well it motivates students to really use the software by learning rote commands.

The “creative process” approach asks the student to learn the software by attempting to design an original building, without the use of any "hand sketching". The requirement to design only "on screen" is necessary, since the habit of the students to design by sketching is quite strong, and left with the option, most students would design the building by hand, and in the last weeks of the semester, model and render the design. This would also reinforce the idea that computers are best used as "post design" modeling and rendering tools, and thereby miss the fundamental benefits "on screen" design provides. The students are made aware of the importance of avoiding handsketching in the context of the classroom, at the same time it is made clear that the normal digitally-based design process is a hybrid handsketching and computer modeling.

course framework

To facilitate the learning of a digital design process the course follows the following five conditions:

1 The student must design entirely “on screen”.
2 The design problem will be simple, allowing the student to concentrate on form creation.” Students cannot use a current studio project as their design problem.
3 There will be only one architectural design problem, although design progress will be evaluated at regular intervals.
4 The students will be given the creative freedom to design individually. This allows the student the maximum level of creative motivation, and allows them to distance this course from the normal studio process. There will, however, be two juries, with outside jurors, where the students must defend their work.
5 The student will create a 600 square inch final poster, which describes the essence of their design. This poster must include at least two rendered views of the proposed design, and incorporate text in a significant way. In addition, there is an expectation of a high level of graphic design in the composition.

The course follows a two part structure: the first half of the semester introduces the process of digital design, the second half studies image creation, both in terms of the rendering and lighting of a single image, as well as, the use of 2D computer graphics as a means of creative expression. The class meets in two sections, a lecture section of approximately two hours per week,which the entire class attends, and two lab sections, one taught by the faculty member and one by a graduate teaching assistant, which meets for four hours per week. The lecture section presents both, theoretical concepts of the use and appropriateness of digital design, and demonstrations of specific software applications. 3D modeling can be taught using a variety of architecture friendly solid modeling programs, however, for this course Form•Z has been chosen as the most architecturally oriented, and as the most effective interface from the standpoint of intuitive "on screen" design. Form•Z does not offer animation, but it does offer shaded rendering, raytracing, and radiosity. In this sense the still image rendering capacity is well suited to the quality range needed by a designer. Solid modeling is critical to the design process, in that the objects created in the program behave as one might intuitively "feel" they do in real experience. Surface modeling programs, by comparison, are perhaps more efficient, but are nonetheless counter intuitive. Photoshop is used as the image editing software. In addition both programs are cross platform from PC to Macintosh. The lab sections concentrate on specific student questions, and one on one assistance with the design problem. Students are expected to have basic computer skills, but there is no specific requirement for 3D modeling or image editing skills. There are 40 seats for the class, and about 65 students apply per semester for admission. 80% of the students have no prior 3D modeling skills. Students are given preference for admission if they have taken Arch 132, a general survey course of computer applications in architecture. The semester is broken into sixteen weeks of instruction. The course had been taught within this framework for the last six semesters. The course is offered for three units of credit.

The first half of the semester begins with a simple site concept, sketched in plan, after this all design work is created "on screen". The plan idea is translated into a massing model, this can be accomplished by scanning the sketch and then tracing it in a solid modeling program. The massing model is manipulated and evaluated until it achieves a fit with the students stated goals and concepts for the design. This preliminary model is reviewed by the class as a whole, this gives the students a chance to see how their progress compares to their peers. When the general massing is acceptable to the student, a process of designing the elevations begins. This sometimes alters the basic massing, but in general the student add detail and depth to the basic form, and an architecture begins to take shape. When the more detailed model is almost finished there is a Juried review. This occurs around mid term, and represents the students first hard grade. At this point the students are about 70% finished with their designs, although the stated target is closer to 85%. The jury evaluates the design on its fit to the students conceptual goals, as well as the technical skill exhibited in its creation. The jurors are all profes-

sional designers, who are familiar with the software used in the class. After this point the students will continue to refine the design for another four weeks, however their attention must shift to the graphic design aspects of their final poster presentation.

The second half of the semester begins with the students bringing examples of graphic design, which they feel is appropriate to their project or they feel moved by in some way. These examples are shared with the class, and a dialogue is begun on the fit of this imagery to their design goals, as well as, suggestions for other ideas they might pursue as an alternative. The goal at this point is for the students to find in their architecture a concept that can be translated into a graphic design structure for their poster. A poster concept sketch is next, followed by a digital mock up of the final poster. The final poster is reviewed in a formal jury setting, allowing for a diversity of feedback on their work. The final jury evaluates the students work equally on the basis of architectural design and graphic design, in addition, modeling and rendering complexity are reviewed. The final grade is based on how well the student was able to use the computer to facilitate their design process.

lecture structure

The class consists of thirteen lectures, these can be broken into three groups. The first group are software tool demonstrations, there are two modeling lectures,one materials / lighting lecture and two image editing lectures. These lectures concentrate on what the software can do, these are similar to an interactive tutorial. The second group of lectures are design process-based. One demonstrates how a building can be designed "on screen" in two hours . This consists of several basic massing techniques, as well as adding several layers of detail to the design. This follows the idea that once students know how the tools work individually, they will the benefit from seeing the tools used in combinations that produce design results efficiently. The second process lecture concentrates on image editing. The third group of six lectures are theory-based, and are listed as follows:

- *Digital Design in the Context of a Large International Practice*. This lecture shows student how direct digital design is used in a 250 person firm, where 80% of the designers design "on screen", and all presentations are created on the computer. This lecture is detail oriented, with descriptions of time budgets for digital vs. analog design, as well as client reactions.

- *Current Digital Design Trends within the Profession at Large.* The lecture shows the work of several architectural firms. It highlights the more experimental uses of computers by architects such as Eisenman, Gehry, and Morphosis. Special emphasis is placed on alternative design forms that seem unique to a digital-based design process.

- *The Transcendence of Light*. This lecture explores the qualities of mood, color and ambience that can be created and enhanced with creative lighting. Examples are shown of computer models, architectural photography, and fine arts paintings. The intent is to show the students alternatives to "noon on a bright sunny day."

- *Graphic Design.* This lecture compares examples of recent as well as historic types of graphic design. The emphasis is on how designers create content and meaning with the images they create, and the variety of compositional techniques that can be used to organize complex and diverse amounts of information. Theories of color balance within in images is discussed, as well as, the use of text as a key compositional element.

- *Photography*. This lecture explores the relevance photography has as an art form concerned with the creation of meaning in imagery. Like digitally-based design, the process of creation is machine-based.

- *Collage*. This lecture examines the history of collage in painting, mixed media, and photography. The intentions of this lecture are similar to the graphic design lecture.

class assignment structure

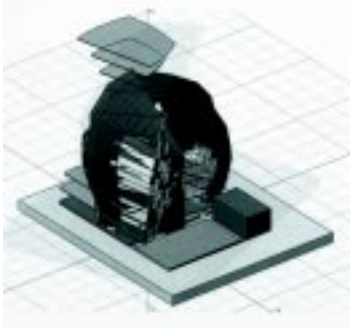

Figure 2a. Preliminary model, by Sean Masuda.

Figure 2b. Preliminary model, by Dennis Martin.

The basic schedule of the class assignments breaks down in the following way:

- *Building Program–Due week 2*. Base Program–200,000 SF Office Building mininum, headquarters for a company of the student's choice; or alternative program: students may propose a program and / or site of their own. Due as noted on class schedule. Caveat: As the intent of this course is to teach the process of digital design, wholly computer-based, proposals may not be for a current or past design studio project.

- *Site Plan Sketch–Due week 2*. Students are allowed two weeks to produce a site plan diagram.Thereafter, all design effort will be made "on screen" without any hand sketching (Figure 1a,b).

- *Preliminary 3D Model–Due week 5 (5%).* General massing of the design plus the beginnings of architectural detail will be expected at this stage (Figure 2a,b,c).

- *85% 3D Model Midterm Grade / Jury Review–Due week 8 (10%). A*. 8.5 x 11 or 11 x 17" greyscale laser prints of your 3D model. This model should clearly delineate your architectural concepts and show the majority of building scale details, this includes, doors, railings, canopies, window mullions, paving patterns, etc. *B.* A brief concept statement should outline the design intent and major elements of the design solution. This statement will be used to establish a conceptual basis for the graphic design effort (Figure 3a,b).

- *Background Photography–Due week 9* (5%). A minimum of 12 photographs should be taken with a 35mm camera, depicting clouds,trees, people, cars and a variety of landscape, building and paving textures. These photos must be scanned into the computer.

- *Final Model / Multiple Views / Rendering–Due week 10* (5%). 8.5 x 11 or 11 x 17 grayscale laser prints of at least three views of your model. Design model should be complete, or almost so. Students should show

materials ideas, and lighting concepts. Viewpoints should have matured to the point where presentation poster options can begin to be discussed.

- *Poster Concept Sketch (see final requirements)–Due week 12* (5%). Third-scale or larger sketches for a 600-800 sq. inch poster which describe the essence of your design. Students will explain their broad graphic design concepts for the development of the final poster. Attention should be paid to the creation of meaning through graphic design.

- *Poster Mock Up–Due week 13* (10%). An 8.5x11 or 11x17 greyscale print of a mock up of your refined poster. Actual "rough" renderings should be used. Students should discuss their compositional ideas as it relates to their intended message. An initial placement of text and background elements is important at this stage. The full Photoshop file at this point should be in layers. The working file can be at a lower resolution (Figure 4a,b).

- *Final Poster / Formal Juried Review–Due week 16* (60%). See Figures 5-15 for examples of final posters. Size: minimum of 600 sq. inches at 100 dpi (20 MB+ flattened). Media: (1) inkjet plot, ideally on glossy paper; and (2) Photoshop 3.0 file(s) and Form•Z file on Zip disk. Each poster must include:

  1. A minimum of two rendered views of proposed design. 3D model must show some sense of real materials. At least one texture map must be used.

  2. One rendered view must contain "entourage" which was created from photographs–e.g. people, trees, light pole, cars, etc.

  3. Text must be used in some significant fashion. Intent: Final image should convey the "essence" of the project, but, will undoubtedly not explain the entire design or context. There is an expectation of a high level of graphic design in the composition. The assembly of elements should convey an image greater than the elements individually.

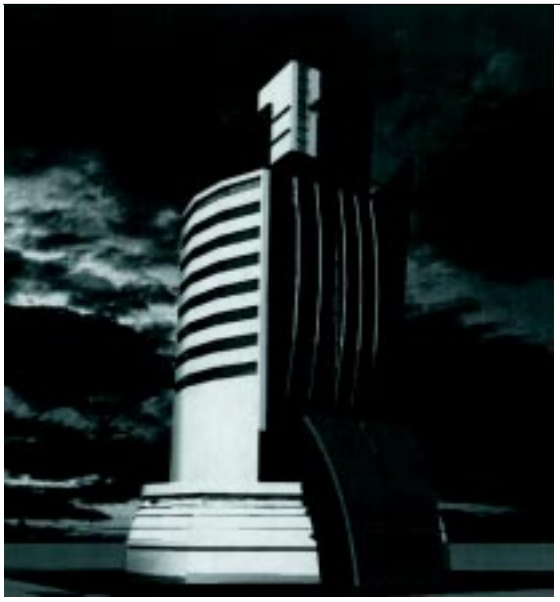

Figure 2c. Preliminary model, by Andrew Wong.

course results

The results of the course can be visually evaluated with the images shown in Figures 5-15. Each semester an exhibition of the work of the previous semester is staged in the lobby of Wurster hall. This exhibit has always generated a positive response, and demand for the course, which is an elective, is about 50% higher than the number of seats available. Based on a five-semester average, the students have rated the course with a 6.27 out of 7.0 and the instructor with a 6.07 out of 7.0. Within the Department of Architecture scores above 5.8 are considered exceptional, with the departmental average being 5.6.

In general the students all came to understand the process of digital-based design, they were differentiated by the level of detail in their models and the degree of sophistication in their architectural designs. One third of the class did very well, maximizing their potentials as designers in their use of the computer, one half did well, understanding completely the process, and were able to create a high quality of architectural and graphic design, one sixth of the class struggled with the process and were able to complete all of the assignments, but with weak submissions. There is usually a group of students that will study complex

Figure 3a. Midterm model, Eugene Wong.

Figure 3b. Midterm model, Cameron Miyasaki.

geometries or organic shapes that clearly would be difficult to approach with traditional tools. These students seem to have an innately sophisticated sense of 3D space, which the programs allow them to explore with greater freedom. Another group of students were able to generate highly sophisticated graphic design concepts for their posters, and it was not uncommon for students to create two posters, while only one is required, in order to explore a number of different graphic approaches to presenting their buildings.

general observations

For most students, the first four weeks of working with a solid modeling program were difficult; it was around the fifth week when they would begin to see the power of the software to realize their aspirations. This is due to two processes which they needed to adjust to: one was the learning curve of the software, the other was the difficulty of designing without sketching. Comments from students who had taken this course in previous semesters would lead me to believe that it takes two to three significant digital design projects for the students to feel that the process is comfortable and allows them to create better architecture.

Although there is an abstract acknowledgement within the administration of the Architecture Department that computers are critical to the future of architectural education, there is only one computer "enhanced" design studio. This studio also deals with other experimental media as well. Digital-based design is only a small part of its focus. The issue of how to incorporate computers into the design process is ongoing, with an element of resistance higher amongst the older faculty.

conclusions

Do we now find ourselves in a position where the tools of creation can adequately match the, increasingly more 3D, formal aspirations of contemporary designers? In the case of student designers, I believe a digital-based design process does more closely match their aspirations, once the learning curve has been scaled. Ultimately this will produce designers with greater formal range, as well as an evaluation process which is more accurate and more deeply 3D at earlier phases.

Obviously the proposed alternative method of teaching digital design is only one of many methods. I believe it has, in our case, been highly successful. Other methods may be just as effective. In the future, when studio instructors become well versed in digital design techniques, and the students treat computer use as incidental, all such courses may be unnecessary.

The format of this course has allowed me to follow the students' design process. The students experience has been successful on two levels. Foremost, their process is more 3D than a traditional process. Students primarily create in an axonometric view, and form is evaluated almost exclusively in axonometric or perspective. The students clearly understood the value of digital design primarily as a design tool, rather than a presentation tool. On a formal level, the shapes they create are much more complex and dynamic, and there is a greater willingness to experiment with forms once considered too difficult to rationalize.

The creative success of the students' work has lead me to the conclusion that a digital design process can be effectively taught as a course independent of the design studio, and that students can learn a complete skill set within one semester. Students are quite capable of designing "on screen" when provided with instruction and support. Based on the quality of the results and the amount of effort the students invest into the course, I believe that the "creative" approach to teaching yields a very high level of motivation.

The long term benefits of this course will only be realized when design studio instructors begin to recognize the limitations of traditional design tools, and embrace the potentials offered by a digital-based design process. This process will fundamentally change the way Architects design, and in the foreseeable future most design will become digitally-based. This shift will result from an acknowledgement that a computer-based process is a substantial improvement over traditional practice. After all, we design buildings not paintings.

Figure 4a. Poster mock-up, Larry Schadt.

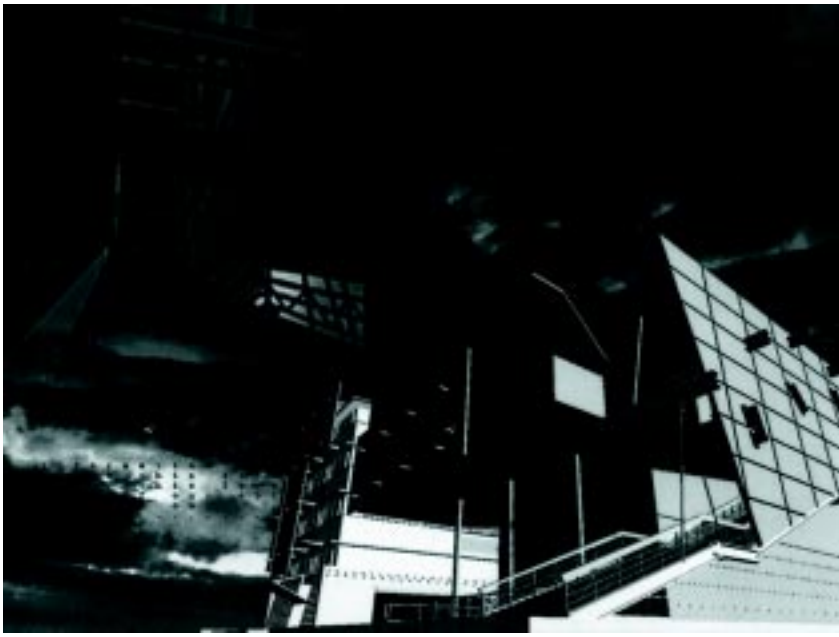

Figure 4b. Poster mock-up, Phillip Ong.

Figure 5. Final poster, Daniel Guich.

Figure 7. Final poster, Jerry Jai.

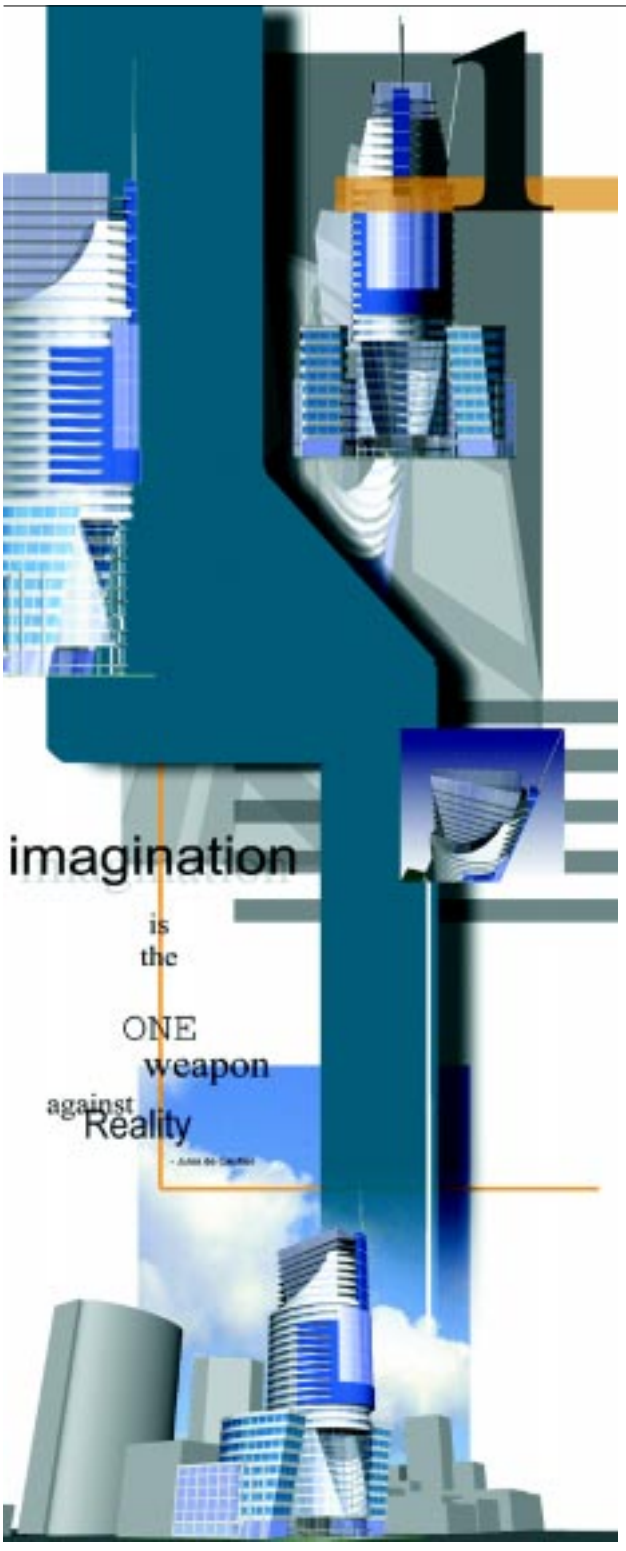

Figure 6. Final poster, by Li Kuo.

suggested readings

Kerlow, Isaac Victor, and Judson Rosebush, *1994. Computer Graphics for Designers and Artists*. New York, NY: Van Nostrand Reinhold.

Mitchell, William J., and Malcolm McCullough, 1995. *Digital Design Media*. New York, NY: Van Nostrand Reinhold.

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Zampi, Giuliano, and Conway Lloyd Morgan, 1995. *Virtual Architecture*. New York, NY: McGraw Hill.

Blackwell, Lewis, and David Carson, 1995. *The End of Print, The Graphic Design of David Carson*. San Francisco, CA: Chronicle Books.

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Heller, Steven, and Seymour Chwast, 1988. Graphic Styles - From Victorian to Post Modern. Harry N. Abrams Inc. New York, NY.

Martin, Diana, and Lynn Haller, 1996. *Street Smart Design*. Cincinnati, OH: North Light Books.

Poynor, Rick, 1993. *The Graphic Edge*. London UK: Booth-Clibborn Editions.

Figure 8,9. Final posters, by Jerry Jai and Vivian Tso (below).

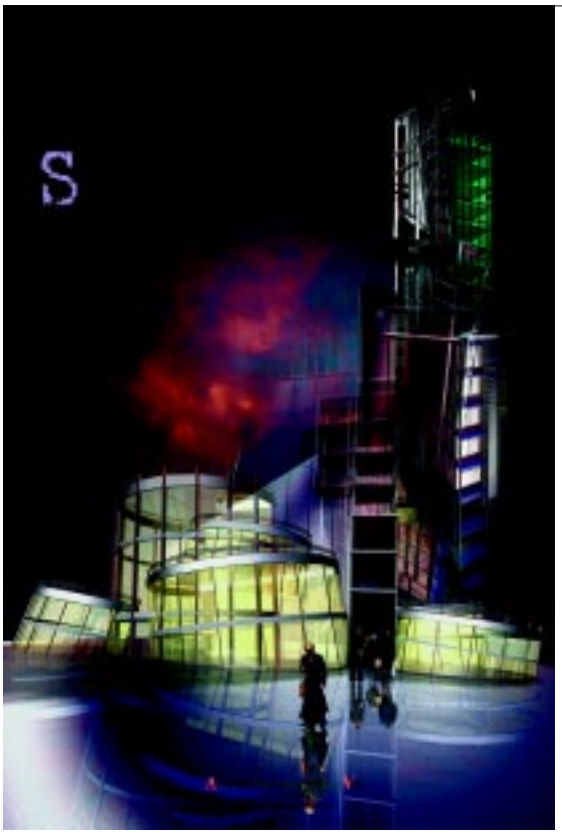

Figure11. Final Poster, by Jen Tzeng.

Figure12. Final poster, by Larry Schadt.

Figure 10. Final poster, by Seonho Hahn.

Figure13. Final poster, by Phillip Ong.

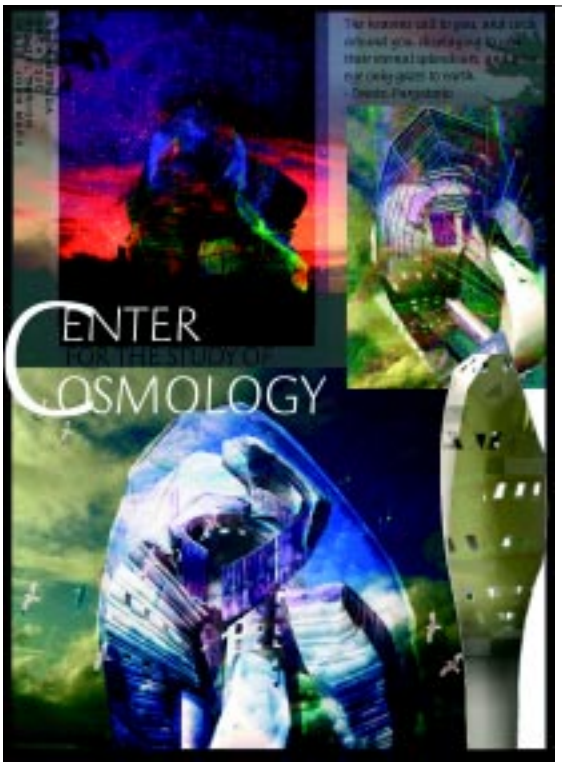

Figure14. Final poster, by Sean Masuda.

Figure15. Final poster, by Andrew Wong (below).