DRAFT

WHAT A DIFFERENCE A TOOL MAKES:
The Evolution of a Computer Design Studio

ABSTRACT

What a Difference a Tool Makes : discoveries made during the evolution of the Advanced Design Studio (a.k.a. "working drawings") at the University of Texas at Austin since the time this core course was switched to computers, when student design teams were provided with computers and required to use them for design and presentation. Covers the period from the course's inception in 1991 to the present, during which the course has been under the continuing aegis of Professor Richard Dodge, who has taught design since 1967.

Contrapuntal presentation by Professor Dodge and co-instructor and former student Marla Smith: what was done, what worked, and what went wrong. Discusses students, faculty, hardware, software, design problems assigned, and the most educational computer-related catastrophes.

1.0 1st Phase: Pioneering 1985 - 1992

1.1 In 1985, with an AT 286, I started seriously training myself to use the computer as a design tool, while working on the U. T. Alumni Center with Charles Moore. The design problem interfaced with the computer modeling I was beginning to use to both create and represent interiors expressive of a place to gather and celebrate. The actual forms I came up with would *not* have been created if I'd been designing the building with my butter paper and fat pencil as I had in the past. By modeling these elements on the computer I could play with infinite variations, leading to forms that had never appeared in my work before. Let me quickly show *you* the first architectural elements showing *me* the difference the computer made:

1.1a The forms in the interior of the rotunda are new and highly influenced by using 3D modeling: (ILLUSTRATION # 1: Rotunda, Alumni Center)

1.1b The ceiling in the banquet hall, (ILLUSTRATION #2: Banquet ceiling);

1.1c and the mosaic of tiles, which became our big selling point for raising money for the building--you could have your name put on the tile. (ILLUSTRATION #3, Tile Courtyard). I must've created hundreds of variations of the tile mosaics using the computer, far more than any sane person would've made by hand. I could change the colors and alter the pattern just the way the uninitiated think the computer works--by pushing a button.

1.2 While learning to play with a new tool I was working with Charles Moore to express *his* fantasy--expressed with the wave of the hand and a little bounce on the heels. I don't

remember consciously connecting the tool with the result until some time later. I also found myself getting into the decorative arts, with a Longhorn Steer I designed to express the playfulness and celebratory nature of the Alumni Center. (ILLUSTRATION #4. Original Long Horn). Let me tell you a quick story about this Long Horn you see on the screen. (Anecdote about Cunningham).

1.3 Although initially disappointed in not getting my way with the Bevo, (the name of the U.T. mascot Longhorn) I was forced to abstract and refine the original. What we ended up with was fabricated from my CAD data and laser-cut in the Houston Shipyard. (ILLUSTRATION #5, Longhorn in front of Alumni Center).

1.4 At this time, the only help I was getting in learning to use the computer was from students working with the computer on their own. Other than that, I read the manual and continued to use the computer in my work outside the classroom, while teaching design class using tools no longer on my own desk. This era could be called the Pioneer Period. Right around then, in 1986, we set up the first computer lab in the School of Architecture at U.T.

1.5 At that time Dean Box needed a conference table in his office and couldn't find one he liked, so I offered to design one. The task challenged me, forcing me to use the computer in new ways. (ILLUSTRATION #6, Dean's Conference table). The shape of the steel--the curved piece you see here--could not have been described for fabrication nearly as effortlessly without the computer. A company in Detroit made the steel piece for us. The stainless steel connecting pieces were also computer generated and made in the U.T. machine shop from my CAD data. The granite bases, on the other hand, were made by hand by a stone mason; I still wouldn't know how to model these artifacts by computer.

1.5a Here's another difference between old and new media: Computers aren't good at predicting a hand crafted shape (or the shape of natural terrain, either) or modeling the result.

1.6 Towards the end of my self-imposed Apprenticeship I stepped down from the Associate Dean's job, which I'd held for many years, and was rewarded with a sabbatical for the Spring semester of 1991, allowing me to visit other schools to see what they were doing with computers. I discovered computing was very much an isolated, elitist enterprise, not yet part of the average student experience. I was determined to teach a class using computers in a setting more like a traditional design studio than a computer lab. (ILLUSTRATION #7, our studio)

1.7 In the Fall of 1991 I began teaching the course I'm teaching now, called Advanced Design and Technical communication in the catalogue, termed Working drawings by the students. We decided to use this class to introduce the computer because it meets 21 hours a week. I'm not using the royal we--if you recall by this time I'm no longer the Asso Dean--but referring to the buzz around the school. Everybody seemed to feel something had to be done about learning and teaching computer skills, but nobody knew what. We talked about it in the Budget Council meetings, we talked about it in the Curriculum committee meetings, we talked about it in the halls and over lunch. I made a proposal to use the class I was teaching for the Maiden Voyage. Until last year, mine was the only design class using computers as the primary mediator between intention and result in architectural design decision making.

1.8 The object was to teach students to use the software at the same time they were learning to design with it. And, given the nature of this course, to learn the way buildings go together and something about the materials they're made of. I was teaching the only section of a required class; students had to take it if they were planning to graduate any time soon. We started

off with six 486 33 Hertz computers and 12 students who just happened to be at that place in the pipeline at that time. We used AutoCad release 11 and 3D Studio Release 1. The machines were slow and our plotting capabilities laughable--we had to go over to the Computer Lab in the building next door to print.

1.9 We had no forebears in this endeavor and had to reinvent a number of things. Desk Crits were out the window. My on-site computer help came from a couple of graduate students, no doubt looked at as geeks at the time. I'd also call Malcolm McCullogh at Harvard to talk me out of a jam. (Malcolm had been on our faculty and got me started in the first place.) Remember, this was before e-mail! No Internet as we know it! I was out there at Fort Austin cut off from the experts with my huddle of students! We worked on a housing-related project and went ahead very traditionally. Looking back, I'd call it a simulation of how we design with pencil and paper, trying to imitate that process because that's what we knew how to do. So there I was, teaching 2D drafting skills before attempting 3D modeling.

1.9a Leading me to the discovery of the first half of what would turn out to be a major difference between the old and the new media: Using the old media, the traditional process was to come up with a schematic, then a preliminary design, then refine, and so on--what I'd call sneaking up on a design, getting closer and closer to what you envision, going from a fluid state to a more concrete representation gradually. At this stage, I couldn't even conceptualize what the new process was; I was learning and teaching simple operational skills, which went on simultaneously with design except for the first 2 weeks of class, when we went through the commands and the basics of how to get around the software. Of the first 12 students, zero knew anything about computers. After two weeks everybody was about at the same place--those who picked things up quicker had helped others who didn't so that we all started off with a basic grasp of how to use the tool.

2.0 The new process wouldn't become clear until the 2nd Phase, or the Transition period from 1992 - 1994.

2.1 This period was one of extensive gains; I'll sum up quickly. Bob Swaffer joined the staff as Director of the Computer Lab. Bob has a Masters' degree in Architecture and a Masters in Computer Science. He had a big job (getting steadily bigger ever since). Computers were suddenly more prevalent in the profession and everybody wanted to know how to use them. You could take classes from a variety of sources in using the software, but none specifically for architects. Trenton Wan, working for Graber Simmons and Cowan, an Austin firm with machines in the office, suggested I teach a course for members of the profession who needed to acquire skills possessed only the new generation of interns at this moment in history. I followed up on his suggestion and gave some summer seminars; Trenton Wan, by the way, never signed up. I only did this for two summers. The problem still remains--commercial classes are very generic and don't deal with the kinds of questions architects ask.

2.2 So what questions *do* architects want answers to? I'd say they're nearly always of a formal nature, having to with the issues of size, shape, proportion, character, context, color, texture, and detail. These are the same questions we want students to grapple with in any design studio. Luckily, computers are extremely useful in responding to these sorts of question.

2.2a Difference the tool makes: At this time both the classes for professionals an my academic class were making it clear they were most interested in 3D modeling. 3D modeling turned out to be the big difference between the old and the new design process, the difference between sneaking up on a design and jumping in early with concrete decisions. With 3D modeling

you have to make decisions such as what materials to use, how to make connections, what are the exact dimensions of every element, and so on.

2.3 By 1993 the class had doubled; we're now up to thirty students. We were phasing out the 486/33's and bringing in Pentium/60's. The two-week skills instruction was out the window; we were jumping right into 3D modeling. The colleague helping me didn't know the computer, but was supposed to pick it up so he could teach with it the following semester. He was the first of four in the same situation, which we repeated for a total of six semesters. They were supposed to be teaching students how to design with a tool they were unfamiliar with. This situation led to peculiar practices, like circumventing the computer during crits--which was a problem. I've heard a definition of insanity as doing the same thing over and over again hoping for different results. Draw your own conclusions.

2.4 By this time two other classes were using computers directly, the design studio taught by Marcus Novak and a class in imaging taught by Owen Cappleman. Marcus's Studio was entirely different from mine; they used the computer as an artistic and creative device inventing whole new realms. Students were excited and stimulated by the class, but since Marcus left no one has been able to fill this slot. Owen's class concentrated on bit-map manipulation, very important to the students in the preparation of presentations and portfolios.

2.5 By now we have major hardware and software improvements:

AutoCad release 12 was a huge improvement over release 11, much more user friendly.

3D Studio2 for rendering, very intuitive and easy to teach. This software was pretty good with materials, color, and exterior lighting, although interior lighting remains difficult.

We are now using 3D modeling straight out of the chute.

We have better machines and technical help by now, but so far no computer-literate assistants for the class.

3.0 Third Phase: Here to Stay 1994 - 1998

3.1 By the period the faculty at U.T. School of Architecture are thinking we'll need more people who can teach design studios using the computer, but the scheme of training our own by apprenticing them has failed. No money or comp-time has been devised to bring design professors up to speed. I have taught a couple of "get comfy with your computer" classes, to no effect. Last year we tried very hard to hire new computer-literate faculty, but if they're out there we haven't found them yet.

3.2. Now, however, I have Marla Smith for my assistant. Marla was a student taking this course in 1994; she's now graduated and become a full-time instructor. Since Marla's been involved during this whole period, she's going to take over and tell you about the final stage of evolution. Her views are particularly important because she's been both a student and instructor. INTRODUCE MARLA.

3.3 Computer Education

Hello. I started the working on the computer in a Dallas High School, about the same time Prof. Dodge did, 1985. One of my teachers, John Moore, managed to get some computers, a program called VersaCAD, and a pen plotter. Mr. Moore learned along with me. My computer skills developed simultaneously with my design skills, so when I went to the University of Virginia School of Architecture (majoring in Architectural History) I was surprised to find the facilities at UVA were behind my High School. No computer courses for undergraduates were offered, an only exploratory courses for advanced graduate students. At Piedmont Virginia Community College I took a course from a woman who worked as a drafting assistant for a local architect. The facilities were good and the teacher was familiar with ACAD R11, but it was a drafting course. This is how the profession first dealt with the computer. I still had not used 3D modeling.

3.4 Computers were getting faster as my skills were developing in design. During all of this computer stuff I began to think of the computer as another tool. It became an extension of my brain, just like a pencil or a pen. I was learning traditional ways of design in studio classes at the same time I was doing projects on mylar and vellum and redrawing them in R11 at PVCC, re-presenting my design. Still, most of my designing was done on the board and not on the screen.

3.5 After I was accepted in the graduate program at UT Austin, I looked forward to working with computers. On a visit to the school I asked to see the computer facilities and was sent off to the basement of Sutton with a wave of a hand and the comment "They're over there. . . I don't know about them. . . ask Bob Swaffar." Only later did I find out that Richard's class was the only design studio using computers, specifically AutoCad. The only other course was an intro. course for AutoCad consisting of reading the manual and doing the tutorials. I took the course, even after being told specifically: "You do know that this counts toward nothing."

3.5a When I was a student of this Working Drawings Class I wanted to learn 3D modeling and increase my knowledge of the computer. When I took the course not many people knew 3D modeling or got that far in the design studio. Prof. Dodge's assistant did not know how to use the computer to design, since he was supposedly learning the same time we did. We had 30 students and two design profs, only one of whom could help with the technical problems or with how to conceptualize using the computer.

3.6 So once again I read the book and taught myself. I spent a good deal of time doing this. Luckily, another student in the class was a big help with the hardware. Without him, my ability at the end of the course to design with the computer would have been far less; he was in the same little cubicle with me and the other half of my design team, another person totally unfamiliar with the computer. I was a designated expert early on, and discovered quickly that some people cannot think with the computer. They are not able to think in a straight linear step by step process or are unable to futz with the way the computer works to ferret out a mode of getting the results they are seeking. How do you get around the "limitations" of the rational mind by thinking around corners? It's hard to teach people that skill. [Tell story about partner. . . fall pallet] I bought my own computer around this time; it was faster than the ones in studio so I worked at home a great deal. I also had R12 and 3DStudio. I took showers and ate dinner while the computer crunched out a rendering.

3.7 The question of students sharing skills: reinventing the wheel Students don't like to help other students or share what they know with other students unless they're pushed to do it. In the college culture, you win if you're the best; you get to be the best with natural ability and hard work. Why share either with your other students? Helping those for whom things came harder is

the teacher's job; for those who don't work hard, forget it. But both as a student and as the assistant teacher for this design studio, I can say that a lot of teaching and learning gets done by sharing with others. Sharing is a matter of geography it seems to me--people help each other who are close by, within about three or four pods. You're there when they turn around and yelp for help, and the other way around. Also you pass by and see what others are doing.

3.8 When I was a student in the class I was called upon to teach others drafting skills using the computer. I didn't want to just do that, even back then. It wasn't that I minded helping with the technical computer stuff, since I knew it and they didn't, but I was already melding the two things, the media and the message. I asked people: what are you trying to accomplish with your design? What do you want the computer to do for you to communicate to others what your design is about? To me the question always has been how do you get the design problem solved, and how does pushing the design through the technical apparatus of the computer representation help in solving the problem? Not the other way around--learn the steps of computer simulation and then incorporate those steps (or invent new ones) into the design. Where, if that happens, is the design actually coming from? What's going on in the brain of the designer? If it can all go on without any medium at all, why do we need drawings to convey what we're doing? That is, if words can be used in the head and on paper, what's a designer using in the head they're not using on the computer?

3.9 To me, handling just the technical problems seems like a minor issue in this design studio to me, but that's not the way students unfamiliar with the computer when they walk in the door see it. I try to move them to considering larger issues early. For instance, the ways the layering system works. It's a technical problem in some respects, a mosaic connecting the project they're working on with the computer--how are they ordering their drawings, and what are the consequences of these decisions? How do they assemble and use blocks of design? What do they bundle together in components in order to save and change later?

3.10 The computer reflects how the designer's mind represents the design. Inherent ordering systems within the designer process the creation of a project into a viable solution. Other ordering systems within the computer-plus-programs demand a systematic approach to accomplish whatever the designer's after, such as editing or coming up with another iteration of a design element. The user's ability to fuse the two systems and bend them to the design need ultimately makes the difference in how useful the computer turns out to be as a design tool.

3.10a Use the computer for what it's good at--like copy the window 12 more times; change the original then push a button and change the rest. Put the window on the network so other people can **use** it, not **copy** it. Use the computer's inherent abilities to share information useful to your design. Take it, change it, test it, leave it, erase it, even redesign it. I try to help students refine their use of the tool, help them see a piece of design and see how it grows and develops using the computer. Richard has them put the most successful solutions to particular design components on the network. In order to create a new culture where sharing is rewarded, nobody gets an A in this class unless they've put something useful on the network for everybody to have a look at and use if they want. As a teacher, I try to discover where students tend to make their mistakes, so I'll know where to guide the next bunch of folks and save us all time.

3.11 Pines Hotel (our most recent project) (ILLUSTRATION # 8)
Standardized layering works for something like The Pines Hotel, but not for individual projects. Example of the use of the computer's inherent organization that conflicts with design organization. We try to push the class's ability to use the tools--help them in overall computer education--put

electronic drawing into page maker and then to the student's portfolio. Nothing motivates more than the words "this'll look good in your portfolio."

3.12 God is in the details. When I was in Hal Box's studio, I used 3D Studio to model the entry court. I was interested in light and the curve of the wall. The first thing Hal asked: That's a strange door knob. How does it work? This particular project *[describe]* was good for doing what Richard mentioned before, forcing the students to deal with the precise reality of their design. The units in particular are useful in the 3D sense. What does your cabinet look like? Where does it hang on the wall? What color is it? More questions and more answers. By using the computer to design this project, the students were compelled to ask questions they could've easily avoided in other media. Hopefully these questions will become an inherent part of their design process, with or without the computer. The movement of scale, the understanding of scale within and without the computer. At first the questions seem trivial--what do you mean what color's the paint? Or--how do I know what the floor's made of?

3.13 "Technique is Discovery." In my own work I ask myself "how can I show this?" at every stop of the design process. I now abstract in my mind what the computer can represent. I can see my design element through the AutoDesk CAD system, then 3D studio, then PhotoShop, then the different print options. The power of the computer and the complexity of the software took off in the last four years. Richard just reminded me the other day when the computer would ask "ARE YOU SURE YOU WANT TO DO THIS?" when you asked for hidden line removal--the reason being it could take two days! The point of telling the War Stories, for those of you who've been in the trenches, is just the fun of sharing; but for those of you who are just embarking on using the computer as a design tool, the major point is that it's a tremendous tool to use. I, of course, didn't have to give up another way of doing things and take years to get up to speed, as Richard did, and neither will those who come after me.

3.14 Who among established faculties is going to take the time? It turns out to be at least a three year commitment. Five years from now we'll be hiring in more faculty like me, and I expect in ten years everybody who shows up will take the computer and it's relationship to design for granted. We teach a great deal of 3D studio; I still have to go home and figure it out before I come back and teach. But you can start teaching before you know everything, as we all know. The software's so tremendous, users tend to find their own way of getting around and don't use more than what is absolutely needed at the moment. To learn you have to be motivated; faculty would probably have to work on their own projects first, as Richard did. And it has to be part of the routine; if you walk away and discontinue use, you'll forget too much. I'd say that schools just instigating a program would do well to go with a section of the
faculty who really want to do it to tide you over until the new techno-architect-academicians of your dreams start turning up.

3.15 Staff and Budget. The main problem at U.T. is that the faculty is not familiar with the programs. Also, *under* the superstructure, what's needed to keep the systems running is discounted, not given the credit deserved or the budget and manpower needed. If the hardware breaks down in the studio we go get Bob Swaffer. Without Bob we're totally vulnerable. But more and more unsupervised and unattended ways of accessing the computer have evolved, and it all falls on Bob's shoulders. What I mean by this is there are three systems: Apple, PC, and Unix. The School of Architecture's considering buying 30 more computers just to have "on hand" for sophomores to learn on. How

are students going to learn the software? How are we going to keep them running? Faculty serving on committees who do not themselves use the computer don't know what questions to ask. *The software can be life swallowing. The hardware's technical and demands attention to detail and dynamic beyond belief.*

3.16 Own Server and Network in the Studio. For our immediate situation it would be helpful for our studio to run in a more independent manner. Still, this requires the teacher to know hardware and networking. Generally, I'd say forget it.

3.17 Pedagogical consequences of introductory period. Hierarchical arrangements between teachers and students break down when the students know more than the teachers. This may be an advantage in the between years (time it takes to get new computer literate faculty). Make a new set of TA's for the computer classes. Teach a few professors and assign a student who really knows their stuff to teach with the professor. It's a version of my job right now. If the studio's MWF from 1-6 then the TA's there on MW.

Concluding Remarks: Richard Dodge

Can teaching students about architecture be improved and enhanced with computing?

I emphatically say "yes." We can ask students to consider a wider range of design questions. We'll need to accelerate the shift from traditional media, of drawing and physical model making. Unfortunately, these media are best suited to exploring the size, shape, and proportion attributes of a design idea while abstracting structure, materials, color, and detail. With computing we can extend explorations further.

We'll need to help students use software and hardware to facilitate experimentation, to test ideas, explore alternatives, and ask a lot of "what if" questions.

The traditional studio mode of desk crits does not work well in a digital studio. Looking at a monitor does not provide a good base for comment. Most of the project's probably not even in the current file; if it is, when reduced to the size of a screen of muti-colored dots and lines, it's hardly worthy of comment.

Students need ready access to plotters and printers. (We have an HP600 plotter in the studio now). We want students to have ready access to the best equipment. At UT we have a computer-use fee that generates about $150,000 per year for the school. Periodically we get an infusion of larger amounts from the university for computing related needs. In my studio we have 15 dedicated computers loaded with AutoCad 14, 3D Studio Max, Photoshop, Pagemaker, MicroSoft Office software, the Ink Jet printer, and postscript printer. All of the computers are linked to our network, which makes for easy access to other peripherals and software in the school. All students and faculty have an email account provided by the university, as well as Internet access from their work stations. Paper for the plotter is paid for from the use fee.

Since my studio started we have cycled computers every five years, replacing three each year. We are moving to a three-year cycle in the Fall. A five-year-old computer is a real dog compared to a

new one. In addition, the newest software puts demands on computing power that the five-year-old machines are incapable of handling.

Some students own their own computers, but we do not require them to bring them to school. If we did, they'd balk. They feel the fee they pay places the burden of providing hardware and software on the school. I suspect they're right. We also don't want the burden of providing technical support for personal equipment. This all adds up to a capital intensive educational environment. I see only two ways to respond to this reality: get more money or teach fewer students.

Computing is most powerful when used to share information. Students need to get in the habit of creating data bases contributing to them and using them. The culture of the traditional design studio seems to promote the notion that design is by definition one person acting alone, and that sharing data (information) will somehow undermine the student's competitive edge. Using computing in the design studio should diffuse this myth.

Computers are not a graphic equalizer, as some might think. The craft of developing a quality computer model and presentation is equal to or more difficult than in any other media. Students need to work with faculty who are skilled in the craft of computer modeling and presentation.

Despite my commitment to helping students use computers creatively for design, I remain convinced of the absolute value of drawing. Making a computer model is not a tactile experience. Perhaps the best route to the brain passes through a tactile media like drawing. I see an educational model in which students spend the first two or three years employing traditional media in their studios. However, they're permitted to employ computing as their desire and skill levels dictate. During this time they take classes in the fundamentals of computing in design. In the final two or three years of their study students should be required to employ computing in design and should be taught by faculty who are skilled in this area.

The fundamentals of computing would include

- layer structures for experimentation
- layer structures for data bases
- accessing data bases, both local and global
- structuring a cad model for experimentation
- creating physical models from cad model
- structuring data to move cad models among software
- integration of analytical software

I think we live in interesting times. Whether you see this as good or bad is up to you.

In a *New Yorker* article on the subject of when we get too old to appreciate the current wave of pop music or to try new food, the author mentions Max Plank's observation that "established generations of scientists never accept new theories; they die first." Some Architects and Academics are never going to learn the computer; they'll die first. Adapting a new design media turns out to be a conversion experience; it's hard to predict who will convert.

Thank you for giving me the opportunity to talk to you about how I've spent my time for over a decade. Now I'd like to have Marla Smith have the last word today.

MARLA SMITH

Detail vs. General Theory

The advantage to getting the details sorted out early in a design has nothing to do with getting the door knobs right. It's my hope that the students who are required to answer the questions we've brought up today will incorporate the answers into their design process at an earlier stage in their development than has been possible up until now. The *idea* of the "thing/design" is not enough--"it" has to be shown. In my own design process, I began with the general and moved to the specific if I had time. No one demanded detail.

More to the point: you don't have to sweat the small stuff if you already know it. If use of the computer is already embedded in the brain, as it is in today's pre-shoolers, then when they get to Architecture school we'll be dealing with a whole different mindset than what we have now.

What I think we're going to see is the collapse of design divisions in relation to a computer program. For instance, Light Scape brings the potential for technical, interior, and architectural representation. We're breaking down divisions between interior design and architectural design, between lighting analysis and designing furniture or interior or exterior sculpture or decoration, like Richard's Bevos.

Thank you for your attention. Now we'd really be disappointed if what we've had to say didn't stimulate any discussion. Now it's your turn. Anybody disagree with *anything* we've said?