Integrating Digital Media in Design Studio: Six Paradigms

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Integrating Digital Media in Design Studio: Six Paradigms

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Abstract

Digital media are transforming the practice and teaching of architecture. This article outlines various ways to integrate computation and digital media into design teaching. It describes six alternative models for 'digital design studios'. Each of these models has been explored in teaching practice to varying degrees and at different schools. This article aims to locate these different approaches and, in a preliminary fashion, to organize efforts to employ digital media in design studio education.

Introduction

Not since the development of perspective drawing in the Renaissance has the practice, technique, and technology of architectural design changed so rapidly and so profoundly as it has following the advent of affordable computers and computer aided design software. Just twenty years ago, students and teachers alike expressed profound doubt—not to say contempt—that computers could play a useful role in architectural design. Today, the opposite is true: Students insist that they must gain computing skills, for CAD is their job ticket and they believe it will make them better designers. Certainly the future will bring even more profound changes. The development of digital media, driven by advances in hardware and fueled by the software industry, shows no signs of slowing. Although they are not yet embedded into commercial design software, new technologies—sketch recognition, speech processing, desktop virtual reality—are on the horizon. We can expect the change we have witnessed in architectural practice and education to accelerate in the coming decade.

As the computer has grown from a bit-map toy to multi-media workstation, teachers have found new applications for computing in the architecture curriculum. With a few exceptions, however, most schools have focused on teaching computer applications and on encouraging students to use computer aided modeling and drafting packages in otherwise conventional design studios.

Since the publication of the proceedings of the 1989 CAAD Futures conference as "The Electronic Design Studio" (McCullough, et al. 1990) many experiments using computers in studio have taken place. We draw primarily on work published in the proceedings of ACADIA (the Association for Computer Aided Design in Architecture), the biennial CAAD Futures conferences, the European conferences eCAADe and AVOCAAD, and the Asian CAADRIA conference. In this brief overview we can only touch on issues that have been the subject of lengthy debate at these other venues. In particular, the proceedings of the 1998 ACADIA conference titled "Digital Design Studios: Do Computers Make a Difference?" is a good place for readers who are unfamiliar with current digital design teaching practice to get a more detailed look at this area.

The following section outlines six models for integrating digital media and computation into design studios. Each addresses a different application of computing in the studio. Although we describe each as a distinct paradigm, in practice the models could well be commingled. The models are as follows:

I. The CAD Studio is a computer augmented design studio. Up-to-date design software is used to teach a conventional design studio.

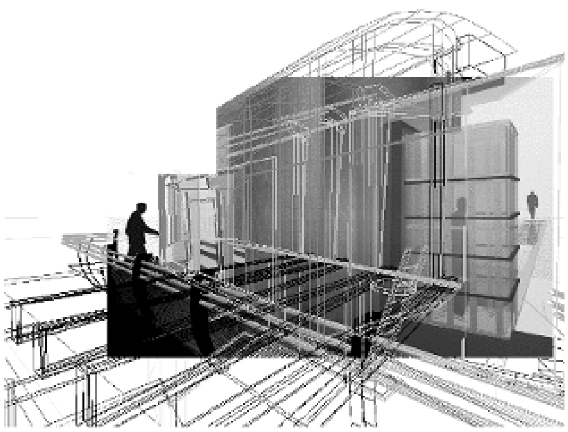
II. The CAD-Plus Studio addresses the integration of knowledge in design.
III. The Virtual and Web Design Studio explores new opportunities for collaboration using the Internet and Web.
IV. The Cyberspace Design Studio addresses the integration of virtual and physical communities.
V. The Intelligent Buildings Studio explores embedding computation and smart materials into the built environment.
VI. The Tools and Toys Studio employs experimental digital design media that may become future tools of practice.

We articulate and give examples of each of these six models, and try to identify the kinds of learning that it represents. The degree of development of the six models varies. Some of the studios are little more than a concept; others have been explored extensively in teaching practice.

The Six Studios

I. Computer Augmented Design Studio

The first and most commonly applied model augments conventional design teaching practice with conventional computer based media. The studio aims to teach the principles of building design. However, students employ form making software in the production of their design representations, sometimes exclusively, but more often combined with traditional media. This includes image processing programs such as PhotoShop, geometric (surface and solid) modeling and rendering programs such as Form•Z, a computer aided drafting program such as AutoCAD; and perhaps an animation program such as 3D Studio to generate walk-through movies.



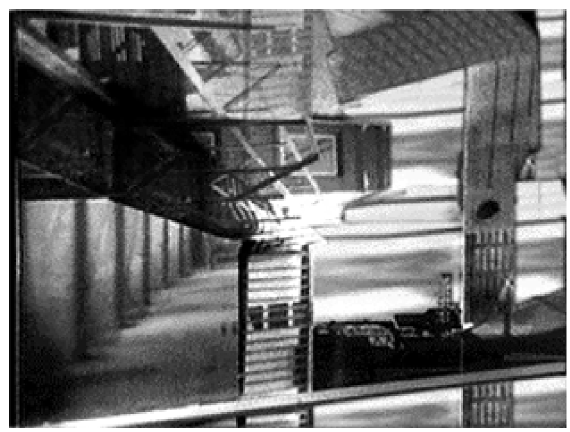


Figure 1. Form Processing CAD studio - computer augmented design studio combined with traditional presentations. Left, Inquiry of Tradition: Expressions in Space (Josh Beck, Form•Z award of distinction, 1997). Right, Analog & Digital Studio (AIA Education Honors Award 1998, Bennett Neiman and Julio Bermudez http://carbon.cudenver.edu/~bneiman/index.html)

Students and instructors are aware of the well-publicized use of computers in offices of famous architects: for example, Eisenman (Giovannini 1993) and Gehry (Gehry 1997). Most now accept that digital media can be used not only to develop designs begun on paper, but to explore new ways of transforming and generating representations of physical form. Most are eager to experiment with these new techniques.

Examples abound. Even without an explicit mandate to use computers in their design work, students are gaining technical skills and applying them in studio. A new generation of students has appeared who have sufficient skill with application software to use the programs as smoothly as previous generations used pencil and tracing paper. For example, one studio at the University of Oregon explored image processing software for the production of designs (Herbert 1995). Students placed drawings as well as physical models on a scanner, then manipulated the scanned images digitally. Tools like PhotoShop enable rapid exploration using traditional visualization techniques such as foreground / background reversal, as well as more sophisticated graphical manipulations that can only be done effectively with digital media, as for example in the "analog and digital" workshops of Neiman & Bermudez (Neiman and Bermudez 1997). Another interesting approach explored at a studio at Florida A&M University took advantage of modeling software to represent forms with movable and folding components, as found for example in transforming toys. Design exercises in the class were structured around the rotation and translation of the parts of a model (Sanchez-del-Valle 1996).

Students who have gained computer applications skills find the CAD Studio model highly attractive: it enables them to sharpen and show their expertise in digital design media. Students who are less familiar with computers require additional technical instruction, which detracts from the studio's main goal of teaching design. Nonetheless, students find that this studio prepares them for the job market and helps them develop attractive portfolio projects. For the most part, they also find it fun.

II. CAD-plus Studio: integrating knowledge about performance into the design process

Curriculum integration has rightly been pointed out as a goal of architectural education (Boyer and Mitgang 1996). Instruction in structural design, environment and behavior concerns, or energy performance of buildings is often relegated to auxiliary specialty courses, a guest lecture in studio, or inviting a specialist expert to participate in a design review. Digital media offer new opportunities to integrate instruction about building performance into design studio without sacrificing the teaching of design.

Although the main focus of design studio is usually form making, computational tools can enhance form making with relevant information about building performance. The CAD-Plus Studio employs computational tools for knowledge-providing and analysis. This enables the integration of knowledge about buildings into the design process earlier and more effectively than in the past.

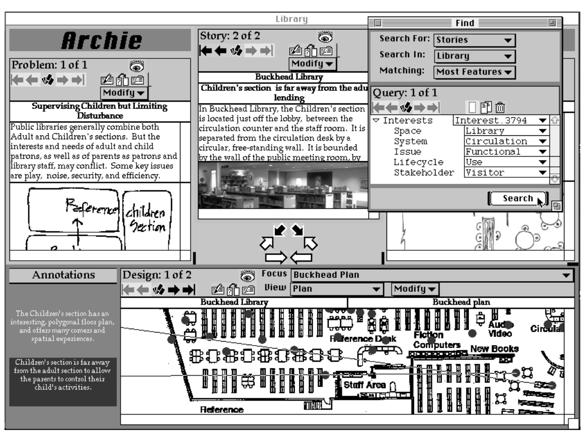


Figure 2. The CAD-plus studio integrates building knowledge into the design process. Here, lessons from Archie are structured as problems, responses, and stories that are cross linked with annotations and the floor plan. (Illustration courtesy Georgia Tech Archie Group)

Like a conventional studio, the CAD-Plus studio focuses on generating physical form. However, the CAD-Plus studio integrates a suite of knowledge tools appropriate to the design project that students can draw on for information and analysis as they carry out their design work. Two types of knowledge based tool stand out as especially appropriate: simulation and analysis programs, and case bases of design information. Students can use simulation tools to analyze lighting (e.g., Lightscape), energy performance (e.g., Energy Scheming), acoustics (Turner and Barnett 1997), and structural support and stability. They can use case libraries to find precedents for their designs, avoid known problems, and adopt and adapt successful design solutions.

The SAM ("Structures and Materials") multimedia case library developed at the Key Centre for Design Computing at the University of Sydney offers students examples of structural design solutions from real case studies. Each SAM entry contains general project data, a description of design requirements, alternatives considered by the engineers, a justification of the chosen design solution, and references where students can find additional information (Maher 1997). Students could search the library to find specific buildings, buildings that use a particular structural system, and solutions to a given loading problem. Similarly, a studio at Georgia Tech that focused on tall buildings used the Archie case library, which provided students with specific design information pertaining to high rise building issues (Zimring, et al. 1995).

III. Virtual and Web Design Studio

The Virtual Design Studio model explores the new ability for design partners who are geographically distributed to use internet and Web technologies to exchange ideas, critiques, and designs. In a virtual design studio, students and instructors in different locations work together on a project. Already some firms carry out their work this way, connecting partners on several continents and time zones, passing design work from one office to the next around the clock.

Figure 3. The Virtual and Web Design Studio explores distance collaboration using digital design media on the Internet and the World Wide Web. Design presentations, annotation and conversations using computer facilitated communication (VDS illustration courtesy J. Wojtowicz).

Early virtual design studio experiments that linked studios at Harvard, MIT, University of British Columbia, Washington University, and Hong Kong University limited communication to email and exchange of CAD and picture files (Wojtowicz 1995). Soon low bandwidth digital video exchange software (such as CU-SeeMe) augmented this, and now Web and Internet collaboration is a rapidly advancing field. Commercial tools for video conferencing, shared whiteboard drawing, and chat rooms as well as more experimental MUDs (multiple user domains) and Moos (object-oriented MUDs) are being explored in virtual design studio projects. A good discussion of the pedagogy of virtual design studios can be found in Tom Kvan's article "Studio Teaching Without Meeting" (Kvan 1997).

It is problematic to motivate a virtual design studio in the conventional architecture school setting. Students are accustomed to working alone on projects for an academic quarter or semester. They resist collaborating. Even using conventional media, group projects are unpopular. After the high-tech novelty wears off, students don't see why they should collaborate with members of a design studio at another school. It does not seem to advance their agenda of producing a design project by the end of the term. Yet even in the artificial world of the design school studio, there are advantages to using the Internet for collaborative design and critiquing. The virtual design studio can connect students with expert consultants and critics who would not otherwise be available to them. For example, in a recent Collaborative On-line ("COOL") studio at Georgia Tech that focused on courthouse design, experts nationwide reviewed and commented on student work (College of Architecture 1998).

An interesting approach to Virtual Design Studio was taken in a recent collaboration among the ETH Zürich, the University of Hong Kong, and the University of Washington. Students at each school worked on a design project, with a different focus in each of five phases. At the end of each phase they submitted three-dimensional models to a shared server, and for the next phase they selected a project from the server that they had not worked on. That is, each student continued a project begun by another student (Kolarevic, et al. 1998).

IV. Cyberspace Design Studio

Moving further from the traditional domain of architectural design, the Cyberspace Design Studio model looks toward new roles for architects in the design of virtual as well as physical places. Already, our public institutions—libraries, government offices, universities—as well as commercial enterprises are extending their physical presence to the Web. The design of these on-line environments present a new world for architects (Anders 1998, Bertol 1997). If architects do not become involved in designing these spaces, others surely will.

The Cyberspace Design Studio draws on what we know about built environments to explore the design of virtual places for public and community activities. For example, navigation and wayfinding are important concerns in virtual places. Popular computer games, such as Myst and Riven, provide lovingly rendered imaginary landscapes and buildings whose physical characteristics help players find their way through the game. Designers of cyberspace environments can take advantage of what is known about wayfinding in buildings and cognitive maps (Strong and Woodbury 1998).

Figure 4. The Cyberspace Design Studio integrates virtual and real building design. Here, a Virtual Museum built in VRML (illustration, courtesy Thomas Jung).

An interesting experiment along these lines is underway. The Association for Computer Aided Design in Architecture (ACADIA) has sponsored a competition for the design of a 'library for the information age' that has both real and virtual components. The strongest entries will draw on the principles of good architectural design as well as knowledge of the digital libraries that are being developed around the world. They will find ways to integrate the physical and virtual so that virtual library users who visit the physical building can feel a familiarity and understanding of the physical place. The competition brief reads, in part,

"This competition calls for design of a library existing in physical or electronic environments, or in both, as a "cybrid" building. This library will offer many of the experiences and spaces of conventional libraries. Yet designs incorporating cyberspaces will have unique characteristics. As renditions of data, these spaces may not resemble conventional rooms at all. They may offer experiences simply unavailable by any other means." (ACADIA 1998)

Many universities are using information and communication technologies to develop distance learning activities. Typically this consists of a web site with text and graphic content, videotaped lectures, and email with the instructor. Researchers at the Key Centre for Design Computing are taking the distance learning concept a step further. Their Virtual Campus project employs a combination of web pages and MUD & Moo technology to provide not only on-line lectures, reading material, and exercises, but also (text based) interaction with other classmates. The Virtual Campus trades on a spatial metaphor:

"The Virtual Campus is an online learning environment that supports both real time interaction with others in the campus and access to learning materials. The Virtual Campus is designed to behave in a similar way to a physical campus. The entrance to the campus is the main hall where Albert is waiting to guide you. From the hall, you can move to one of four areas: offices, classrooms, resources or professional. Each of these areas provides entry to a number of other rooms for more specific purposes." [http://moo.arch.usyd.edu.au:7778/]

V. Intelligent Buildings Studio

The Intelligent Buildings Studio recognizes that information technology, in the form of smart materials, sensors, actuators, and microprocessors, will become literally part of the woodwork in buildings of the future. A natural extension of 'building as machine', responsive buildings have been the stuff of science fiction for over a hundred years. In the 'sixties and 'seventies we began to see efforts to construct responsive buildings (Allen 1974, Negroponte 1975). We have buildings that respond actively to geoseismic motion and intelligent controls for HVAC systems. Others are in experimental stages: panels that can change their light and heat transmission characteristics; ubiquitous computing in which the building senses the locations of its inhabitants and dynamically serves their communication needs. These are simple and crude versions of what is to come. Architects must learn to design with this new generation of building materials, and come to terms with this new concept of building as a computational entity. For example, computer scientist Mike Mozer wired up his house with sensors and programmed it using neural networks to learn his patterns of turning on and off lights, heat, and appliances (Mozer 1988), http://www.cs.colorado.edu/~mozer/nnh/index.html.

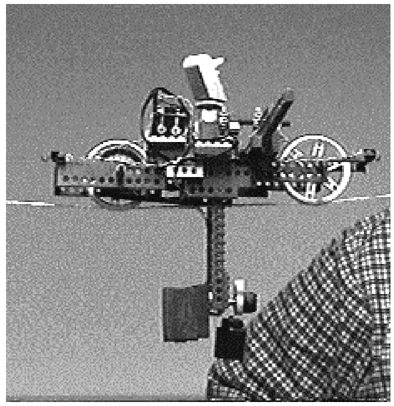


Figure 5. The Intelligent Buildings Studio integrates building technology and information technology into design of building that responds to changes in the physical environment. Here, self balancing moving vehicle: Toys with embedded computer microchips have motion, sound, and light sensors.

In a workshop course at the University of Colorado, we teamed architecture students with students from the computer science department. They worked with "Crickets", microprocessor devices with sensors and actuators (light, sound, and pressure detectors, and motors) that can be easily programmed using a version of the children's programming language Logo (Resnick 1993). Students were asked to embed computation into physical environments and models. This required them to solve problems with the electronics, mechanics, and software of their designs while finding elegant ways to integrate digital and physical craft.

VI. Toys & Tools Studio

The Toys & Tools studio explores next generation software and its effects on architecture. This studio focuses on innovative computational environments for design. Although experimental prototypes of tomorrow's design tools are necessarily fragile and awkwardly conceived (Noble 1998), still students can profit from experience with alternative and forward looking computational design environments.

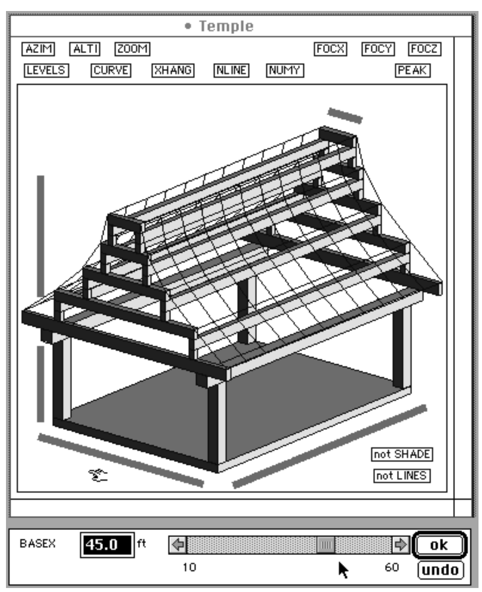


Figure 6. Toys and Tools Studio. A Chinese Temple in TopDown, in which a designer can manipulate parameters such as the width, length, roof pitch, and different structure of the timber construction.

The Toys & Tools studio recognizes the development cycle of design software. Professional design tools such as AutoCAD, PhotoShop, ArcInfo, Form•Z were anticipated by research prototypes ("toys") developed in laboratories as much as ten to fifteen years earlier. In many cases these laboratories were associated with schools of architecture (Mitchell 1977). Students can get a glimpse of the design environments they will use in the future by trying out research prototypes being developed today. Although prototype software can be frustrating—it crashes; it is limited compared with commercial products—the Toys & Tools Studio offers a glimpse of this future. It encourages students to take a more dynamic view of the capabilities and possible effects of digital media on architectural design.

For example, in the early 1990's, a simple parametric design toy—Milton Tan's "TopDown" program—was employed in design exercises at Harvard's Graduate School of Design (Mitchell, et al. 1990). Tan's program allowed students to specify, by writing a few lines of computer code, the variation of a family of forms. When Tan introduced TopDown in 1987, parametric variation was a novel concept in architectural design software, although it had been featured in mechanical CAD for several years. Since then, parametrics have become a standard feature of architectural CAD packages and they are rapidly being incorporated in the lexicon of digital design environments.

Experiments with virtual reality is another example of bringing tomorrow's design technology into design studio and reviews. Explorations at the Bauhaus University Weimar (Donath and Regenbrecht 1996) and the University of Washington (Davidson and Cambell 1996) showed that virtual reality can offer attractive, though still primitive, design environments.

Discussion

The six models for studio integration of digital media certainly do not cover the ground, but they do provide orienting landmarks. We have portrayed the models as distinct, but combining the models may make sense. We have also tried to indicate where efforts have been made to explore or realize these models.

The first digital design studio model—the CAD Studio—is clearly the easiest to implement, as instructors and students become familiar with the palette of digital media. The other models require the instructor to make a greater investment in going beyond the traditional bounds of architectural design. For example, the Cyberspace Design studio requires teaching students to build on-line places, which involves mastering a gamut of technologies—Quicktime VR, VRML, MUDs—that are not part of professional practice today. The Intelligent Buildings studio requires a working knowledge of new communication and engineering technologies. For some studio instructors, these distractions will be welcome; others will merely find them a nuisance. For the latter, one rewarding strategy is to develop interdisciplinary teaching approaches with other faculty members who are adept at these technologies, and who might be interested in their application in architectural design.

The practice and teaching of architectural design is changing radically in response to the new digital media that augment, if not replace, traditional paper and pencil drawings and basswood and chipboard models. The change, spurred by technology, reflects changes in society at large as well, as the information age takes hold on our communities and society. For many years, it has been said that the discipline of architecture is in crisis; yet architecture reinvents itself again and again to respond to a constantly changing societal context. Once more, we must reconceive the roles and practice of architectural design, as we find ways to incorporate digital media and computation in design teaching and practice.

Schools of architecture must be leaders, not merely consumers, in developing design practice with digital media and anticipate, not just adopt, technological change. Architecture schools, like architects, must work with technology and must work to make it more useful. New digital design media have great potential; we must turn this potential into reality. We are shapers and makers by trade. We must live up to this tradition in the way we teach design with digital media.

Acknowledgments

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