

LEARNING VIRTUALLY: A PARADIGM SHIFT IN DESIGN EDUCATION

JAMAL AL-QAWASMI
*Jordan University of Science and Technology
and Texas A&M University
qawasmij@yahoo.com*

Abstract. We still think of architectural design education in terms of a “classroom” paradigm, that is, of an instructor teaching design skills to a class of students in a face-to-face format. However, emerging communication and collaboration technologies have created tremendous new opportunities to distribute students and faculty, while maintaining a close personal contact. This paper discusses and characterizes several aspects of the evolving paradigm of teaching design made possible by the ability to work in shared virtual environments.

1. Introduction

The design studio remains at the core of architectural education. Traditional architectural curricula have been based on the design studio model which emphasizes learning by doing. Under this model, a typical architectural curriculum offers a sequence of design studios in which students learn to design by actually engaging in designing.

In such studios, students undertake one or more design projects. In the traditional studio, students usually record their design ideas using sketches, detailed drawings and 3D physical models. At intervals throughout the project, the instructor holds individual or group face-to-face crits and reviews. The electronic design studio later introduced computer-aided design (CAD) systems as an alternative to physical media as a tool to communicate and represent design ideas. More recently, the virtual design studio has been introduced in many architectural schools as a yet another way of teaching architectural design. Using communication and collaboration tools, a virtual design studio allows students and instructors who are geographically dispersed to interact, form teams, conduct virtual reviews, and participate in crits via their desktop computer.

Over the last few years, a number of architectural schools in the United States, Europe, and Asia have conducted experimental virtual design studios.

In these studios, students from geographically separated educational institutions work together using digital media as if they were part of one design studio. A few of these experimental studios have exploited compressed videoconferencing technologies (Vasquez de Velasco, 1997, 1998). Most of them, however, used Internet-based collaboration technology, synchronous and asynchronous, to maintain contact between the geographically distributed team members (Chen et al., 1994; Tan & Teh, 1995; Maher & Saad, 1995; Kolarevic et al, 1998; Dave & Danahy, 1998).

Asynchronous tools are computer-mediated environments that enable students to interact and share information asynchronously by storing and retrieving data from a shared location. These tools include the File Transfer Protocol (ftp), e-mail, shared databases, and the World Wide Web (WWW). These tools enable students and instructors to publish, retrieve, and exchange graphics, images, textual comments and attachments of sketches and drawings. As such they support asynchronous reflections, group discussions and brain storming, and the exchange of ideas and representations.

Synchronous tools are computer-mediated environments that allow a group of users who are geographically dispersed to interact simultaneously through their desktop workstations. These include tools such as text-based chat, digital whiteboard, audio and video conference, interactive sharing of 3D models. Multi-channel tools that combine several of these media into one package, such as CU-SeeMe, have also been introduced. These tools allow users engage in live interaction using communication channels while simultaneously working on a shared 3D model or a raster image.

In many respects the virtual design studio experiments are breaking new ground in the teaching of architecture. However, their utility has been limited primarily to allowing students to collaborate with students in other educational institutions using Internet communication tools to solve architectural design problems. In addition to teaching basic design skills, these experiments attempted to instill teamwork values and to expose students to foreign environments and ideas in a direct fashion. This paper points out other possible implementations of the virtual design studio. It characterizes and discusses several aspects of the new paradigm of teaching and learning design virtually and how it can bring dramatic changes to architectural education, theory and practice. In particular, the paper discusses how the new paradigm can enhance design learning experience, expose students to a variety of experiences usually faced in practice, and increase access to architectural education for a wide variety of potential students.

2. The New Paradigm

While some disciplines still argue or resist the use of technology in classes, for nearly two decades architectural schools have been using computers and integrating them into the classroom, in what is called the electronic design studio. Recently, the virtual design studio has been introduced in many architectural schools as a new way of practicing and teaching architectural design. Unfortunately, in many aspects, the virtual design studio is still bound to the traditional mode of studios. Educators and researchers still think of the virtual studio as complementary to the traditional or electronic design studio. We tend to consider virtual design studios to be enabled or networked electronic design studios. Currently, the virtual design studio is offered by a limited number of schools within the framework of the traditional curriculum and not on a continuous basis. It is offered as enrichment to the traditional curriculum as any other enrichment studio, such as the design-build studio. Within this framework, the studio is defined and maintained by instructors and students with most of teaching activities occurring within the boundaries of the studio. This limited perspective puts great constraints on our understanding of the new pedagogical environment. The virtual design studio will remain experimental and discretionary to the extent to which we conduct it within, and think about it in terms of, the prevailing teaching model.

The virtual design studio, however, is not only augmenting the current system of architectural education, but also changing it. The virtual studio questions several values associated with traditional architectural education and brings dramatic changes to the architecture curriculum. The virtual studio can transform the architectural design experience; bring desired changes to basic assumptions, theories and practices of traditional design education; and increase access to higher education for students not able to utilize traditional campus offerings. Proper understanding of the virtual design studio requires a new perspective that goes beyond the discourse of the current paradigm. The new teaching environment can be utilized much better if we deal with it as a manifestation of a shift in the current paradigm of design education.

The notion of "paradigm shift" was discussed in depth by the philosopher of science Thomas Kuhn (1970). Kuhn proposed that theoretical revision in the natural sciences takes place in stages. He proposed that a mature stage of "normal" science when there is relative consensus about how to carry out investigations (i.e., a "paradigm") is typically followed by a stage of uncertainty or reconsideration of the traditional ways of doing things, which is then followed by the establishment of a new paradigm reflecting changed understandings, assumptions, or technologies.

In the traditional architectural curriculum, there has been a reasonable consensus on how to teach architecture. The curriculum contains several diverse and disparate topics that are pursued concurrently in separate courses.

The design studio forms the core of this curriculum. In the course of a studio, students undertake one or more design projects under the supervision of an instructor. Each student is to develop a unique version of the design. The instructor holds individual or group reviews with students. All these learning activities occur within the studio boundaries. Thus one can describe, in Kuhn's sense of the term, a pedagogical paradigm that characterizes architectural design education.

A substantial shift in architectural design education has been occurring during the last decade or so. The introduction of the virtual design studio has resulted in a major shift in perspective, and a reorientation in theoretical and conceptual assumptions considered to be central to the prevailing paradigm, thus putting strain on its adequacy. The virtual design studio breaks the time and space limitations of the "classroom" paradigm; reduces or eliminates the separation of the theoretical aspects of design from design studio; integrates diverse courses within the design studio; exposes students to other teaching and practicing methods; enables continuous access to architectural precedents, visual libraries, and work of other students; provides a student-centered rather than teacher-centered learning environment; and establishes a flexible, distributed, non-hierarchical, and many-to-many student-teacher relationship. These transformations are not manifestations of technological change but reflective of a paradigm in the process of shifting. The conventional paradigm of teaching design is transforming and is slowly giving way to a new way of teaching architectural design. In this new paradigm, the design studio is about affording connections between students, instructors, resources, and knowledge, inside and outside the studio.

Dealing with current experimental virtual design studios as manifestations of an evolving paradigm not yet dominant will enable us to fully utilize the capabilities of the new teaching environment. *Integration* of the virtual studio into the current model of teaching is not the best way to exploit this new pedagogical environment. The virtual design studio is a call to rethink design education rather than a call to integrate new technology into an old education model. Virtual teaching can, and probably should, be used to reconsider and revise the current model of teaching design. It provides promising opportunities to break free from the bounds of the prevailing paradigm of design teaching and to explore new theoretical and conceptual assumptions to advance new pedagogical models.

If the virtual design studio is a manifestation of a transformation or shift in the field, then what will the new paradigm look like? The following is a discussion of some aspects of the new paradigm of teaching and learning design virtually.

3. Transformation of Design Education

Traditional design education has several limitations such as design projects are usually hypothetical and not related to real world, and many theoretical aspects of design are taught in separate courses. The new paradigm can provide solutions to these limitations and others. The virtual design studio, for example, can link design education to a real world with budget, clients, resources, and material. Instructors can propose design projects with real sites and real clients. Students can use synchronous and asynchronous collaboration tools to contact and interact with the client from their studio or wherever they may be. They also can access the Web for up-to-date manufacturer specifications and standards of products and materials. Experts can also be brought virtually in the studio to provide specialized information and consultations.

The virtual studio also opens architectural schools to communities and other architectural schools nationally and internationally. Architectural schools can establish a virtual studio that would serve as a center for community-based projects. The virtual studio will minimize the efforts and logistics needed to work on community-based projects. In such a studio students can work and interact with multi-disciplinary teams that include community members, planners, city governments, and other entities involved in design and construction. In this context, a virtual studio will enable architectural schools to shape distinct educational agendas particular to their local environments as well as to remote environments. The virtual design studio can also expose students to different forms of teaching and practicing architecture in other schools and countries. The virtual design studio can be used, for example, to form multi-disciplinary teams from students of different departments such as architecture, planning, landscape architecture, and construction. Forming virtual teams of architecture and landscape architecture students to work on a site development project, for example, may have several advantages.

The traditional architectural curriculum suffers from the separation of the theoretical part of design education from the design studio. One of the concerns with the traditional curriculum has been how to integrate the knowledge of structural systems, construction methods, architectural theory and history, and other courses into the design studio. Brady (1996) pointed out that design education tends to be disparate, with different topics pursued concurrently in separate courses. She argued that this disparate approach does not serve architectural education especially in upper level studios, where the emphasis is on the integration of a multitude of issues related to a project type. She emphasizes that "it is difficult for upper level studio to integrate the information from related coarse work when it is offered during the same term, as the schedule for covering topics in related lecture courses may not coincide with when the information is needed for a studio project." In the new

paradigm, the design studio can be seen and utilized as an environment that integrates the disparate elements within the curriculum. Computer-mediated collaboration technology and other digital technologies can integrate the disparate elements within the curriculum and link the theoretical part of design education into the design studio. For example, professional training or internship and professional practice courses could be integrated with the design studio or campus activities. A virtual studio can provide access to distributed digital libraries of historical and modern building types. Structural systems and construction methods can be integrated with design teaching. Actual projects can be used as case studies to demonstrate different building systems and construction methods and materials. A virtual construction process can be demonstrated using 3D and 4D CAD to enhance learning about construction knowledge. Students, in the Design Media course I teach at Texas A&M for example, have been creating 3D models of construction system components and producing animations that simulate the construction process. The design studio thus serves as a context or container for the rest of the curriculum.

Design education depends on exposing students to previous examples of architecture- architectural precedents. Architectural precedents usually come from different places and must be understood within the cultural and social contexts of these places. To expose students to foreign environments, ideas, and practices, many architectural schools have invested heavily in study abroad and other off-campus programs (Vasquez de Velasco, 1998). In the new paradigm, information and collaboration technologies can support and augment the current practices of these programs in two ways. First, students can conduct virtual contacts with other cultures instead of moving physically there. This will minimize a lot of the logistics needed for physical mobility and thus may increase the number of participants in these programs. Previous research showed that virtual contact promotes real contact rather than discourage it (Vasquez de Velasco, 1998). This research also pointed out that virtual contacts with other cultures is a powerful resource for exposing students to other cultures and practices and for providing an international and multicultural dimension to undergraduate programs. Second, collaboration technology will enable students who choose to participate in a real study abroad or any other off-campus program to draw upon expertise at the main campus. Off-campus programs will be better integrated into main campus activities, improving the profile of off-campus programs and increasing the diversity of students' experience.

Working virtually will enable faculty to be more efficient. Using a virtual teaching environment a faculty member can now teach from his or her office, while a student works at home or a networked studio, undertake an internship at a professional practice, or wherever he may be. In this model students are also introduced to different interest areas, multi-disciplinary teams, new forms of

practicing architecture, and potential markets for architectural services. Exposing students to such a variety of experiences could foster a range of career paths. Furthermore, previous learning scenarios indicate that architectural design is moving toward "democratization" and thus toward higher education role in fostering a free and democratic society.

4. New Forms of Learning

Higher education in general is facing several challenges. In United States and most of the world higher education is mired in a crisis of access, cost and flexibility (Dionne and Kean, 1997). Several other factors such as rapid advances in Information Technology, more diverse student and faculty population, and global education and practice opportunities have pushed toward adopting distributed learning environments. Emerging telecomputing and information technologies enabled the delivery of educational services to anyone, anywhere, at any time, confined no longer to the campus or the academic schedule. Administrators, legislators, and critics and reformers of higher education are increasingly embracing digital education and distance learning modes as more flexible and cost-effective alternatives to on-campus teaching to make services available to a wider, more varied population. The virtual teaching of design enhances a school of architecture's capacity to respond to the challenges and opportunities imposed by rapid advances in telecomputing and information technologies.

As the complexity of our contemporary society increases, its need for the services provided by architectural schools will continue to grow. Architectural schools like other higher education entities will be challenged to meet the needs of the growing population of adult learners in the workplace seeking to enhance their careers and keep pace with new knowledge. In addition to the traditional style of "just-in-case" education in which students complete degree programs long before they actually need the knowledge, the virtual studio enables new forms of teaching and learning. The virtual design studio, for example, can enable a "just-in-time" education in which education is sought when one needs to enhance his skills or to keep pace with technology through non-degree or continuous education programs, or a "just-for-you" education in which special educational programs are tailored to meet the specific lifelong learning needs of particular students.

In a virtual teaching model, practicing professionals can participate in courses without having to leave their place of work, yet obtain personal interaction with architectural school faculty. Courses focused on specialized professional knowledge such as health care systems, facility management, global practice and others could be offered to people in practice using a studio format. A graduate program could be devised such that working architects could

earn a Masters degree as a part time endeavor or night school, while retaining professional employment. Furthermore, a faculty member can teach from his or her office, while a student sits in a networked studio, works at home, undertake an internship at a professional practice, or participates in an off-campus study program. A mentor or a guest critic could inspect a student's work and interact with the student without ever having to travel to campus. These learning scenarios and others are all very practical given current computer-mediated collaborative technology. Unfortunately, there is little experience with them among architectural educators.

Recently there have been efforts to expand current practices of virtual design studio to cover other areas of design education. At Texas A&M we have been practicing and examining virtual crits and juries (Al-Qawasmi, 1999c). There have been other efforts at Prairie View A&M to establish a virtual mentor program using ProjectCenter. Faculty of Architecture at the University of Sydney has recently offered the Virtual Campus¹ to provide an opportunity for graduate students to study via an Internet learning environment. Currently the Virtual Campus offers a limited number of courses or "academic units". However, they expect to "have enough units of study available for graduate students to complete a Graduate Certificate via Internet learning."

5. Synchronous vs. Asynchronous Learning

Design education is an intersubjective and social process, involving hands-on activities to develop skills in design and visual communication. Design education is a process of *learning by doing*. Students learn problem solving, decision making, and other design skills by practicing them and by getting feedback from the instructor through review and critique their design products. In their search for solutions to a design problem, students learn not only the facts of the problematic situation but also the process of designing. In his book *Educating the Reflective Practitioner*, Schön (1987) described this "knowing-in-action" process as a tacit knowledge. He pointed out that tacit knowledge constitutes an important part of architectural knowledge and that a major part of design studio activities is tailored to develop skills and knowledge comprising this knowledge. Synchronous interaction and engagement between instructor and students is essential to produce and gain such tacit knowledge. Live interaction, whether in a face-to-face or virtual setting, is fundamental if we expect students to learn design process and to develop design products that are coherent and consistent. This is probably the reason for using live interaction tools such as audio and video conferencing since the first experimental virtual design studio.

Using desktop video-conferencing and other synchronous collaboration environments enable students and instructors to interact in real time through

their desktop workstations, in much the same way that they do in a traditional face-to-face studio. Previous research showed that a multichannel collaboration environment such as NetMeeting enables geographically distributed students to conduct a successful synchronous interaction (Al-Qawasmi, 1999a & b). Such environments allow students and instructors to have concurrent access to a 2D or 3D digital model of the proposal "on the table" and allow them to point and refer to it, analyze it, rotate it, modify it, and have a two- or multi-way audio and video interaction.

Some research has pointed out that live video is not essential for conducting an effective collaborative design (Al-Qawasmi, 1999a). Other research indicated that using a text-based chat instead of audio does not affect quality of communication and interaction between design team members or the quality of design decisions (Versa et al., 1998). However, there is no research that supports the idea that students of design may learn or perform better using asynchronous rather than synchronous learning modes.

Asynchronous collaboration technology, such as e-mail, WWW, discussion forums, and group document editing are attractive for some disciplines that are fact-based, not skill development-based. Asynchronous collaborative environments are mainly text-based and support asynchronous interaction, reflection, and exchange of ideas and representation among users. These tools are mainly oriented to support group discussions and brain storming, and thus alone cannot support the virtual teaching of design, which depends heavily upon synchronous interaction about graphical representation. Asynchronous collaboration environments may be efficient for teaching a fact-based course in architecture or for providing enrichment for an electronic or virtual design studio, but when the aim is development of skills in design and visual communication, it is a very poor substitute for face-to-face or synchronous interaction.

The Effect of Technology

Previous research pointed out that the most critical challenge in running a virtual design studio is the heavy use of telecomputing and network technologies. Internet-based virtual design studio depends on several services and resources such as computers, networks, and servers. More than likely an unexpected event will happen. The server that supports e-mail and Internet access can go down. Heavily used networks may result in a slow or jerky interactive digital models, or in the loss of audio or video signals, or when things go bad, both (Al-Qawasmi, 1999b). Even strong advocates of technology-assisted education are forced to admit that technology can fail. Reports on experimental virtual design studios point out that such technical problems have a negative impact on knowledge delivery and achieving

instructional targets. If virtual design teaching is to become widely accepted, these technical issues need to be controlled and minimized or eliminated. Neither those who embrace virtual design studio nor those who discern problems with it want to see technology misapplied or curricula deviate from their instructional targets through inadequate or inappropriate application. It is hoped that as technology gets better and better many of these technical problems will be minimized or eliminated.

Virtual design studio, however, is not about networking and technical support. More important is understanding the new environment and how it affects design education. Teaching architectural design in a virtual world brings with it other procedural, pedagogical, social, and cultural challenges to both students and instructors. The success of a virtual design depends on how we understand and accommodate the new media to our needs as much as it depends upon effective technological support. Several studies on the virtual design studio have reported the need to study and understand the effect of communication and collaboration media on students and faculty and on teaching architectural design in general (Chen et al., 1994; Wojtowicz, 1995; Dave & Danahy, 1998; Al-Qawasmi, 1999a). As a new phenomenon, little research has been done to study the new distributed teaching environments and how they affect design education and design process. There is also a need to experiment with the various forms of the emerging paradigm of virtual learning and teaching and to assess their impact on design education. In addition, there is a need to examine the new realities created by introducing networks and communication technology in the design studio and to assess the gains and losses associated with having the field moved into a new set of assumptions. We need to examine, for example, how the new environment will affect student-teacher relationships, prevailing design studio practices and rituals, and what new teaching and learning styles are possible with the new environment.

6. Conclusion

The virtual teaching of design points to a new way of practicing and teaching architectural design. The virtual design studio is not a future possibility for which architectural education must prepare. It is a present day reality whose growth potential is virtually unlimited. Virtual design studio, if used properly, can bring dramatic desired changes to architectural education, theory and practice. It can enhance design learning experience, expose students to a variety of experiences usually faced in practice, and increase access to architectural education for a wide variety of potential students. The virtual design studio, however, still raises a number of technical, procedural, and academic issues that have to be examined carefully to determine its impact on faculty, students, and design learning in general.

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¹See http://www.arch.su.edu.au/internet_learning/