The Computer and the Studio

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Abstract: The studio is the primary place of architectural education - the place where the warp of representation and the weft of technique are woven together. Architecture is taught as a domain of ideas, ideas about how and why buildings are built, about the dialectic between concept and materiality. To the architectural student, the drawing is the exemplar of the quality of work he or she will expect in the final construction process. As such, it is very important that the student appreciate the "materiality" of the work to be realized, and this is best done through the education of the whole person, of the entire cognitive mechanism, which most certainly includes the hands. We feel strongly that the student must engage in the creative process in a profoundly physical way, must learn the art and joy of making things, and only then can she or he appreciate the representational abstraction offered by the computer.

In a recent essay, Garry Stevens [Stev97] argued that after more than 30 years of development of computer applications in architecture, CAD was a disappointment. It had not lived up to its promise. This viewpoint was lent an air of credibility because the author had long been an advocate of CAD, and had taught CAD classes for many years. This is not a viewpoint that I share, although I argue here that the role of the computer in the architectural design studio ought to be carefully limited, I continue to believe that computer applications will profoundly alter the nature of architectural design. While these are two distinct issues - whether CAD has fulfilled its "promise" and the role of the computer in the studio - both issues and their inter-relationship must be understood in order to properly evaluate either. Several strands must be braided together: What is the objective of architectural education? What should CAD be contributing, both to education and to the profession? What is the role of representation in architecture?

If we look first at the current state of CAD software, we see an anomaly: a new technology used to produce an old technology. CAD creates drawings designed to be read by construction workers who will manually interpret their instructions. The contention that CAD has not lived up to its promise has to be considered in this context, and one must ask exactly what was its' "promise?" The author expected a dramatic increase in the speed of the design process, and it has not materialized. I would contend that we are (of course) only at the beginning of the application of computers to architecture and construction. The real "promise" of the computer is not in the area of contemporary CAD, but in the application of the computer to the construction process - to robotized construction. This is where we can foresee a revolutionary transformation of the design process and the associated representational mechanisms. Historically, architecture has advanced when either a new construction technology or a new representational modality was introduced, e.g. the cutting of stone or the invention of perspective. CAD has not resulted in either, yet.

Why will robotized construction result in the radical transformation of architecture, and why will it transform the nature of computer applications? Primarily because the construction of a model within the computer is literally the model for the construction of reality, i.e. the methodology for the description of the computer model will mimic the actual construction. This is definitely not the case with current CAD, but in the environment we foresee for a robot-facilitated fabrication the method of construction will be a central focus of the design process. The architect will sit at a computer, and a building will result, without further human intervention. The confirmation of this projection for the future can be seen in the recent change in terminology and conceptualization adopted by the US National Institute of Standards and Technology. It decided to follow its current CAD specification IGES (Initial Graphics Exchange Specification) with a new standard PDES (Product Definition Exchange Standard), reflecting a decision to move away from "drawing" as a means of design specification to manufacturing method as a design definition.

Robin Evans [Evan97:156] has noted: "I was ... struck by what seemed at the time the peculiar disadvantage under

which architects labour, never working directly with the object of their thought, always working at it through some intervening medium, almost always the drawing, ...". This observation, made about current architectural practice, whether involving the computer or not, reflects an alienation inherent in the discipline. When I was a student, we were advised that if we possibly could, we should try to find summer employment in the construction trades. (In the New York City area, this was very rarely possible) The hope was that such an opportunity would lessen the aforementioned alienation, but since few could experience this; our exposure to the reality of architecture was limited to a few field trips to construction sites, and to the activity in the studio.

The studio is the primary place of architectural education - the place where the warp of representation and the weft of technique are woven together. Architecture is taught as a domain of ideas, ideas about how and why buildings are built, about the dialectic between concept and materiality. Because we cannot provide, nor is the student ready for, an opportunity to engage in actual construction, we make models (in many senses) of the construction and the scale of an architectural design. Drawing is a one of these models.

To the architectural student, the drawing is the exemplar of the quality of work he or she will expect in the final construction process. As such, it is very important that the student appreciate the "materiality" of the work to be realized, and this is best done through the education of the whole person, of the entire cognitive mechanism, which most certainly includes the hands. We feel strongly that the student must engage in the creative process in a profoundly physical way, must learn the art and joy of making things, and only then can she or he appreciate the representational abstraction offered by the computer.

We do not fear the computer - we fear its' misuse. We fear its' appropriation to the objective of a short-circuiting of the educational process. We do not have any computers in our design studios, but we have offered courses in computer graphics and image processing for over 12 years. Today a computer applications course is required of all entering students, where it is combined with descriptive geometry. These students learn a variety of computer applications, including computer-aided drafting software used in professional practice. Students may, if they wish, use computer generated output as aids in their design presentations, and their utilization of such techniques is evaluated by the same criteria as any other representational modality: Does the representation support, illuminate and elaborate the design concept? We believe that it can, but that the student must first master the material process of making things, and that this requires, quite literally, "hands-on experience".

Some are convinced that I am the opponent of the computer in architecture, that my opposition to the computer-based studio is a rejection of the future. The reality is that I have been the proponent of the computer's application to architecture for more than 30 years, and have made seminal contributions to the development of CAD. Indeed, my comments at the beginning of this essay reflect my impatience with the pace of these developments, and are indications of my frustration with the lack of serious research in many aspects of computer applications in architecture. Very few schools conduct any research, and my efforts to find sources of support in the United States for research in construction robotics have been fruitless. At the same time, I am a teacher, and have a responsibility to my students to their fullest intellectual development. As I indicated above, this means their entire cognitive mechanism. Consequently, I have adopted educational strategies which mix a solid foundation in principles of computer representation with the acquisition of manual skills which contribute to intellectual development. Some examples support this:

Many, if not most, of the schools of architecture and engineering in the USA have abandoned the teaching of Descriptive Geometry, in the belief that CAD has made it superfluous [Chai97]. I find this to be the equivalent of saying that we no longer need to teach mathematics since we all can use calculators. My students are required to learn a CAD application (Microstation) and apply it to a variety of two and three-dimensional problems. They are also required to learn descriptive geometry, but must do their assignments by hand. While I am convinced that the students learn the material better by the manual reinforcement, it is the students themselves who, at the end of a year of instruction, endorse the strategy. By contrast, I recently had the experience of encountering a recent alumnus of a renowned graduate school of architecture (my students of descriptive geometry are undergraduate freshmen) who was in her first professional position as a computer-based designer due to her "mastery" of a computer-based studio in school. When I asked her how she would go about producing a "true shape view" of a sloping roof, she was unable to answer, seeking refuge in a classic deconstructivist assertion that "truth was subjective".

On occasion, I teach a class in desktop publishing and graphic design, and have found that I must supplement the typically computer-based instruction with manual instruction in lettering. This happens because many students have had no exposure to lettering except on the computer, and do not appreciate the connection between letterforms and their spacing, and the mobile and tactile sensations of the hand. Invariably, the students endorse this perception after the exposure to calligraphy, and the quality of the work they subsequently produce on the computer confirms it.

A recent documentary film explored the differences between technical education in the US and in Germany. The film clearly asserted that the metalworkers in Germany were much more skilled than their colleagues in the US, and indicated that he likely explanation lay in the different educational methods used in the two countries. German metalworkers had to undergo a long apprenticeship program, at the start of which they spent months filing a piece metal, while the American students went right to the instruction on the numerically controlled metalworking machines, the most advanced in the world. Why did the German workers end up with better skills than the Americans did? Was it because somehow tedious work was good for the soul? It was, I think, because those German students came to understand the behavior of metal in an intimate way. The architectural studio is the last opportunity to learn the skills and attention to detail we cherish and expect of our practitioners. We must assure that they receive a complete education.

What sort of educational environment ought we to foster with respect to the current and future role of the computer in architecture? It is clear the professional workplace is heavily dependent on the use of CAD, so our students must learn CAD fundamentals. I stress "fundamentals", since the very volatile nature of computer software requires the student to be able to understand and adapt to the rapid changes in the industry. Focusing instead on always having the latest and most current software is often distracting from the acquisition of these fundamentals. At the same time, as researchers we ought to be involved in the development of new concepts and techniques, and an active research program will engage students more in the "currency" of computers in architectural design, and foster an appreciation for novel applications. In summary, the computer must have a strong presence in the education process, but that does not necessarily translate into their prevalence in the design studio. Adjacency is quite adequate, and supports the continuation of education in hand-eye coordination vital to an architectural sensibility.

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