# Too Much To Do in Too Little Time and it's Getting Late: The Dilemma of Computers in Architectural Education

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## THE DILEMMA

For students in schools of architecture, recent advances in computer technology hold both the promise of greater control over the design process and greater relevance for their role in its production. For architectural educators, there is little doubt that these machines will have a profound impact on these students' careers. However, integrating this technology into our curriculums poses a difficult dilemma.

On the one hand, we have emerging hardware and software that no longer allow us to deny its importance. Three-dimensional modeling, animation, and computer-aided design and drafting (CAD) point to rendering and presentation capabilities that are far superior to hand drawn sketches — even if the glaring images sometimes lack the sensitivity and warmth of pen and ink. Room size projections and full-color high-resolution output dazzle an audience with motion, multiple views, walk-throughs, and flyovers. The power of these presentations and their potential to display virtual worlds of color, perspective, shade, and shadow overwhelms the senses and pleases our clients. As educators, we cannot deny that this technology is impressive.

On the other hand, while this technology promises so much for the future of architecture, we also know that its constantly escalating cost and the amount of time that even the simplest computer illustration demands, places unrealistic constraints on the kind of courses and the quantity of material we can provide. Even in the best financed architectural schools, the constant drive to upgrade this technology and locate it within our curriculums often saps the strength of administration, faculty, and students. Developments in computer technology drive a relentless pace set by the complexity of our highly industrialized society. As educators, we also know that in a semester long course, a student cannot master the technical skills required to manipulate this equipment at its full potential. In the end, their rudimentary knowledge generalizes their designs because the learning curve for the software leaves too little time to focus on the social and cultural implications of their buildings. And when we add the preparation time these programs require of faculty, we see the pedagogical challenge facing schools of architecture today.

The dilemma is therefore clear. On one hand there is the technology in all its glory and on the other is the reality of its use in a curriculum already strained by a range of equally important issues.

## TWO REACTIONS TO THIS DILEMMA

There are two extreme reactions to this dilemma. The first is to ignore the technology and hope it goes away. This is the head-in-the-sand approach where we believe that if we just stick to the old ways, the world will somehow come to its senses (Wack 95). In this approach, some schools reach back to the arts and crafts era, others look for a niche in historical preservation, ecology, or construction. Senior faculty avoid the dilemma through early retirement and abandon the attempt all together. Others, quite understandably, remain in the background and count the years toward their own retirement, confident the next generation of professors will somehow figure it out.

The second extreme is to resolve the problem by throwing technology at it. Here the idea is that if we sprinkle enough of these machines liberally through the halls of an architectural school, maybe their very presence will spark the changes necessary for their own implementation. The logic is that if the challenge is the technology, perhaps the technology itself will find its own way. In this regard, some institutions boast the fact that every student in the school has a computer on their drawing board. They have Pentiums or PowerMacs, equipped with the latest hardware — 32 to 64 megabytes of RAM, hard-disks surpassing gigabytes, and fast-reading, quad-speed CD-ROM players. The machines are loaded with the most recent upgrades of CAD, animation, and other graphic software. There are computer labs with workstations running complex CAD programs on high-resolution monitors and files beamed via telecommunications technology and the Internet. There are rooms with racks filled with scanners, videos, digital cameras, color laser and ink-jet printers, and others filled with last years outdated 486s, Quadra 660s, external hard-drives, plotters, and VGA monitors.

And what does such technology accomplish? Some students find themselves developing skills that make them valuable as computer artists and animators. They abandon their architectural careers and take well paying positions drawing "virtual architecture" as game illustrators. Others spend long hours developing web-pages and look for relationships with distant students surfing across the Internet. Discussing not architecture, but the technology itself. They play with the images of buildings without finding meaningful skills that provide them employment once they have graduated and post these drawings to web-pages that fascinate their sense of creativity. Not seeing that it is the technology that enamors their senses and not the human spaces they too often fail to define. The serious students change their majors and study programming, hardware or software design, robotics, and smart-systems that advance the science of computers in architecture and feed the very fire that inflames the dilemma we all face. And for many students, there is an outright rejection, almost a revulsion at the sterility and loneliness of the computer screen and its endless frustrations. Even with its dithered colors, quick-time movies, and texture-maps, these students seek an aesthetic and sensual world that seems pushed to the margins of architectural education. **A** world that is a relic of the traditions we once shared as a design profession.

## WHAT CAN WE DO?

In the midst of this technological response, we teachers stand in awe at what can and cannot be done with these machines that have found their way into our studios. No one is quite convinced that a paint-rendered image of some elaborately configured, patched and extruded CAD model is more valid as architecture because of its complex forms and brilliant colors — yet the promise of the technology is haunting. In the end, we have architecture that dazzles by the pixelization of its presentation, but some wonder about the validity of its form, its humanity and social meaning. What the machines can do is so intriguing that what the buildings they represent **cannot** do fades slowly with the images that emerge fromour four-color laser printers.

Sadly, neither of these extremes does much to serve the industry for which we prepare our students. In the first, if we ignore the technology, we miss the fact that every architect should be able to use this equipment. If only, because the other professions in the design and construction industry are developing their own proficiencies with these devices. To maintain some relevance in our profession, each student must be prepared to embrace the computer if they expect to remain competitive in their practices.

In the second extreme, schools provide computer technology without guidance and sacrifice many pedagogical insights in the process. Simple access is insufficient. It extends the vocabulary of computer literacy without providing the definitions required for its application to architecture in a meaningful way. Here we train equipment operators without giving them a clear direction in which to go. When they graduate, they find few architectural offices looking for autodidactic virtual animators and fewer willing to pay for their feeble CAD drafting skills — even when the company's hardware and software are compatible with the ones used in a student's education. In the end, our graduates often find they have few employment options from which to choose. After years of paying tuition, they do not qualify to enter the design profession and hold quickly outdated computer skills with little understanding of the architectural processes to which they apply.

## IS THERE ANOTHER WAY?

The dilemma therefore remains. How do we incorporate this demanding technology into an already crowded curriculum? When we give up the time these tools require, we sacrifice the depth of social and technical knowledge that we know is important for our students to understand. And if we devote the scarce resources we have to provide this technology, we commit to a never ending loop of upgrades, new courses, more powerful hardware, and even greater demands on faculty schedules.

Is there another way? This paper suggests that the solution to this dilemma may be as simple as taking the computer out of our studios. This would allow design teachers the time they need to concentrate on lessons that build an intuitive sense of the social implications of architecture.

What then, you might ask, would happen to the need for integrating computers in architecture? Would we not be taking the head-in-the-sand approach discussed above? Quite the contrary, the notion of removing computers from a design studio simply suggests rethinking their place in architectural education. We must begin this rethinking by asking ourselves: Did the computer create a revolution in design or a revolution in its practice?

## AN INFORMATION REVOLUTION

In a September 1995 discussion with our school advisory board, clearly the greatest challenge for contemporary architects is to manage the complexity of their practices. They have less time, face greater demands, and process more information than sometimes seems possible. To meet this challenge, they use the computer to communicate and control the design process. It is a tool to write letters, memos, and specifications. They enter numbers onto spreadsheets and make schedules, graphs, and charts for presentations. They use computers to regularly transfer diagrams, photos, and files to proposals and marketing materials and mix this information into multimedia correspondence from project to project. When it is practical, they use CAD programs, but a simple desktop computer estimates when this technology is appropriate. Virtual computer models are as expensive as equally detailed physical models and architects provide either to clients willing to pay for them as extra services. And again, a basic computer defines these services and justifies the additional expense to the client.

Practicing architects spend less time with their drawings and much more in meetings and on telephones coordinating their production. The computer revolution for working architects has not changed the power of good design. What has changed is the quantity of information that must be processed as a result. It is now less the representation of an idea and much more the communication of its production. What the profession faces is an overload of client, consultant, and product information that shifts the focus of architectural practice. This shift must also influence the way it is taught.

Understanding this revolution calls on educators to re-think the application of computers in our classrooms. We must teach students to use these machines to manage and communicate. When we remove our focus from computer graphics and replace it with an emphasis on computer mediated communication (Santoro 95), we look to control the data that flows in the interaction of practice. This idea uses these machines to manage the entire production of architecture and not just to illustrate its design. When students learn to control a project's production with information, they will have more time to explore design in their studios, study the details of its construction, and focus on all the ways it might be expressed.

This suggests that students should use computers in the classroom much as they will use them in actual practice. Their coursework must include spreadsheets, word-processing, desk-top publishing, charts, schedules, diagrams, graphs, and databases. These applications fit easily into classes like materials, professional practice, mechanical and environmental systems, structures, acoustics, and construction technology. They are common software applications run on simple operating systems that do not require a great deal of memory or time to learn. The upgrades are inexpensive and once students understand the principles, they can quickly translate their skills to other software or hardware platforms. Unlike three-minute color flybys produced on graphic workstations, programs like these require smaller and more conventional computers. Most important of all, these basic applications empower students in the same ways they empower professional designers. They improve critical thought, manage information, and help them express their ideas.

For example, in an advanced materials class taught in the Fall of 1995, students used a single software program to mix words, drawings, spreadsheets, and charts (Apple 93). The objective of the class was for students to understand how buildings worked as a system and how architects communicate their construction. To meet this objective, the class reviewed four semesters of construction methods and details and the organization of a full set of construction documents. Students learned how to use "mockups" and how they communicate design. Computer information systems and computer mediated communications were introduced with the regular course material. Handouts and project assignments were delivered electronically and students talked with their team members via E-mail. Using clearly defined roles and positive interdependence (Johnson 1994), students synthesized their knowledge and achieved consensus with the computer managing their assignments and communications (Szabo 95). As a final project, each student wrote a multimedia marketing proposal for a set of specified architectural services. This included diagrams of their buildings, simple structural layouts, sections, and a sheet by sheet breakdown of their architectural fees. To put this document together, students worked in teams to compose their diagrams and spreadsheets and refine their computer skills. They exchanged this data as attachments to E-mail and cut and pasted the information into their individual proposals. The final documents were laser printed and submitted as hard-copy, but students could have delivered them on disk or as an electronically merged team document.

Students could have also mixed the data into a standalone program to let clients interact with the proposal independent of their presentation. This includes memos and letters that can contain video and sound. It could also include multimedia presentations in a conference room or downloadable information from the Internet. The list goes on and on. Clearly, the potential of the combination of these applications show great promise to control and communicate information in the design process. In many ways this potential far exceeds the most heavily marketed CAD and modeling programs.

## AN INFORMATION SYSTEM FOR LESS THAN $100

What might an information system look like that uses these applications? Consider a collection of software similar to those discussed in the example above. These applications can communicate and manage the production of a building through variable combinations of their data. Sort parameters built into an information system links this data according to user defined requirements. Such a system can reside in a program that cost less than $100 (Apple 1995). It can transfer "living" data through a hypergraphic index. This is living data because the system is on-line to a network of other computers allowing continual updates during the design and construction process. This interface is hypergraphic because mouse clicks on its diagrams help the user access its information.

The hypergraphic index leads to a hierarchy of relational information about the general form of a building, its interior spaces, structural and mechanical systems, and construction details. In this way, information defines the design instead of an illustration. With information, a designer can examine the building as a total or partial assembly, break it down into any combination of materials, and construct or de-construct it piece by piece. This examination views variable combinations of data made visible because fields in the database relate them to each other. These fields distinguish the material, manufacturer, construction sequence, value, and other related information. Both the data and its hypergraphic representation are therefore available for selection and manipulation according to user defined criteria.

The designer uses this information system to evaluate alternatives and the effect of those alternatives on a design's production. The system allows ongoing what-if animations of various combinations of products and materials that are being considered for a design. The direct association of information means the designer can analyze and simulate different takeoff quantities, life-cycle, budget, and construction schedules. He or she can also mix this with up-to-the-minute data on style, color, texture, shade, shadow, or specifications for alternate materials. The depth of this information goes beyond catalog copies of manufacturers' specifications. Instead of quickly outdated printed literature, one finds relevant information on product availability, shipping and delivery dates, quality control evaluations, and video images of the manufacturing process. This also means the use of a material or product can be evaluated according to any number of parameters. This includes the source of raw materials, environmental impacts from their use, and unexpected variables that may occur in their production.

## INFORMATION SYSTEMS RESOLVE THE DILEMMA

This information system can control and communicate the production of architecture. The potential of such a system is important because it could put the architect into the position of the principal systems operator. This channels the exchange of technical data as a function of design. How the designer deals with this information, how he or she sorts it and moves it in the production of a building, is very important to architectural educators.

Most important, the information system in this example runs on a basic desktop computer. It uses readily available software and is accessible through a simple user constructed hypergraphic interface. In addition, because the technology is transparent, instructors can introduce the computer without interrupting course objectives or the school's curriculum. They simply deliver their assignments electronically and encourage students to turn in their project using the appropriate software.

If every technical class presents its lessons so that they fit a common electronic format, it gives the students the opportunity to create a single information system. This system would gather the technical knowledge students receive in their architectural education. They would therefore learn these subjects while they learn to manage and archive the information they cover. This archive is the core of an information system. It informs the student's studio projects and is available for reference throughout their professional careers. The students access this information through an interface that suits their own sense of order. These interfaces can be graphical, menu-driven, list-based, or almost anything else imaginable (Fluckiger 95). In their simplest form, class notes would be available for keyword searches in a basic database. In a more complex form, the text mixes with graphics, or charts and other information provided by other team members. This would include spreadsheet, word processing, and graphic files from class assignments. As the information system evolves, it links multimedia files such as video, sound, photos, CAD documents, or virtual animations. For a studio project, the student might sort and reconfigure the data to control a design's development and communicate the results. Students could link or download information from web-sites or other Internet sources and use them to inform their projects.

What this means is that the use of computers in architectural education parallels its use in professional practice. Students learn how to use the computer in their coursework and it reinforces the quality of their regular assignments. Therefore, they gain proficiency in its operations and learn how to manage the information that they acquire. As their abilities increase, they use the computer to provide data to backup their ideas, analyze different shapes, and diagram or formally present the result.

Important is that this is done with inexpensive and readily available computer applications that are found not only in professional practice, but in our own administrative offices. Critical is that integration of the computer into architectural schools in this way supports the teaching objectives that are already part of the existing curriculum. In other words, useful everyday computer technology is placed into the curriculum to strengthen a student's ability to support their design products. This teaches students to use the computer and its software productively and results in immediate and long-term benefits to their architectural careers. By the time they graduate, the foundations of a lifelong information system are complete. The accumulated data — abstracts, graphics, computations, and reports — can then be uploaded to compact disks and available for future projects. It is also the core of an interactive electronic resume. Information systems similar to the ones our students could possess would intrigue practicing architects because it is technology that parallels their competitive interests. They would see in an electronic portfolio not only the images of designs, but the interaction of software programs as a collection of computer mediated communications. This would show the depth of the student's technical knowledge and their ability to use the computer in actual practice. This is important and immediately applicable to the operation of a design firm.

## CONCLUSION

The difficulty of meeting the challenges posed by these new technologies lays at the threshold of the architectural institutions responsible for the curriculums that trains our industry. These institutions must learn the strategies necessary for future generations of architects to find their place in a rapidly changing professional environment. Practicing architects no longer need graduates who can work as draftspersons and develop slowly under the wing of senior staff. In this computerized society, the quick hand and eye of an illustrator is no longer sufficient. The client expects far more than pretty pictures, even if they are computer generated. The industry calls on today's graduates to be all things, in any situation, at any time. They must understand finance, community issues, contractors, project managers, and an increasing variety of consultants. Each person on the design and construction team has specialized applications, customized spreadsheets, and prototypical files. The speed and efficiency of their technology make it difficult for them to wait for the subtle social and cultural meanings that architects once had the leisure to provide. We must teach our students to manage and control an overwhelming flow of information so that they can find the time for good design.

The dilemma we face as educators therefore threatens our entire profession. Can we maintain the pace of technical development when the cost means we must sacrifice the objectives that have traditionally defined our very identity as design professionals? How do we make the fundamental changes necessary to integrate computers into our schools and avoid the loss of these traditions? And how do we help our graduates be relevant in a future we can only begin to imagine?

Once we take our focus away from expensive computer graphic technology, we can see the obviousness of integrating computers in our curriculums under a single information system. When we loose this myopic focus, we find that the computer has the power to organize the knowledge that is fundamental to the technology of our industry. This knowledge is information that can be the foundation of the success of our designs. If we turn away from the graphic glamor, we and our students are free to explore the implications of their ideas, unencumbered by the time and money required to keep pace with a relentless technical marketing mechanism.

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