The Impact of Information Technology on Architectural Education in the 21st Century

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Abstract

Architecture is a technology-intensive discipline. It uses technology—both in the process of designing and in its products—to achieve certain functional, cultural, social, economic, and other goals. In turn, technology transforms the discipline. The importance of technology to the discipline and to the practice of architecture has been demonstrated again and again throughout history. In the 21st century, the advent of computer-aided design, computer-assisted collaboration, construction automation, "intelligent" buildings, and "virtual" places, promise to have as much of an impact on architectural design processes and products as earlier technological advances have had. Like most other early adoptions of a technology, the first uses of computing in the service of architecture mimicked older methods: electronic drafting, modeling, and rendering. But this rather timid introduction is changing rapidly: new design and evaluation tools allow architects to imagine new building forms, more responsive (and environmentally more responsible) buildings, even radically new types of environments that blend physical with virtual space. Communication and collaboration tools allow architects, engineers, contractors, clients, and others to work much more closely than was possible before, resulting in more complex, more innovative, and more effective designs. Understanding and shaping this transformation are the basis of architectural education in the 21st century.

1. The effects of technology on Architecture

Architecture is a technology-intensive discipline. It uses technology—both in the process of designing and in its products—to achieve certain functional, cultural, social, economic, and other goals. In turn, technology transforms the discipline. The importance of technology to the discipline and to the practice of architecture, and through them to society as a whole, has been demonstrated again and again in history: the adaptation of the Etruscan keystone arch enabled Roman engineers to build extremely strong and durable bridges, and led them to invent the dome as early as 27 BC. The invention of the Flying Buttress allowed 12th century Master Builders to replace the Romanesque's massive walls by the relatively thin and tall walls and soaring vaulted ceilings of the Gothic Cathedral. The invention of perspective and scale drawings in the 15th century radically transformed the practice and products of architecture, and created the office of the Architect, as distinct from the Master Builder. Henry Bessemer's invention of mass produced steel in 1855, coupled with Elisha Otis' invention of the safety elevator in 1853, and Werner von Siemens invention of the electric elevator in 1880, allowed architects such as Daniel Burnham to design and build skyscrapers as early as 1902.

Thus, technological innovations—often several of them coming together at the same time—have always had a significant impact on the discipline and practice of architecture. In the 21st century, the advent of computer-aided design, computer-assisted collaboration, computer-assisted construction technologies, computer-controlled buildings, and Internet-

based “virtual” places, promise to have as much of an impact on architectural design processes and products as these earlier technological advances have had.

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2. Computing in Architecture

The introduction of computer technology has provided architects with new affordances and has begun to displace previous design technologies. It is obvious that the efficiency, control, and intelligence made possible by computational tools are increasingly essential to architectural practices. But it is less obvious how this technology has begun to influence the discipline and the practice of architecture, the society they serve, and therefore the education of architects.

The effect of new technologies on our lives is rarely guided by reflection. Rather, we adapt to the changing technological context. The effect of these adaptations eventually becomes known, but by then our lives, practices, and environments have been irreversibly changed—often with unintended consequences. The advent of the automobile at the beginning of the 20th century is a case in point: it was intended to be a means of transportation, not much different than the horse and carriage that preceded it (indeed, it was called a “horseless carriage”). Its inventors and users have never imagined that this purely technological devise will lead to the creation of suburbs, freeways, shopping malls, drive-throughs (and drive-bys), to global dependence on oil along with its political consequences, global warming, and more.

The transformation of the computer itself provides further evidence to this socio-technological phenomenon: when general purpose computers were first introduced after World War II, they were giant monochrome machines tended to by people wearing white shirts and black ties. They cost millions of dollars, filled entire rooms, and were used for such tasks as accounting and statistical calculations. They were icons of governmental power: there was nothing “personal” about them. The counterculture of the 1960s loathed them.

Only 50 years later, with the help of many technological improvements, the computer came to be seen as empowering people, rather than suppressing them. And their use has proliferated to every aspect of our lives, changing our lives immeasurably from what they were in 1960s.

Four decades after the first introduction of computers into architecture, their effects on the discipline, the practice, and the products of Architecture are becoming evident. As educators and researchers, we must examine the premises and purposes of the new technologies so that we may assess what has been displaced and adapted, what has been gained, what is new, and predict and direct the future of our discipline along with the affordances of the

new technologies. It is not enough to assume that our new design technologies help architects to work more intelligently, more responsibly, more effectively, and more collaboratively. Rather, it is necessary to understand that design technologies also change our perceptions and influence our work, sometimes (often?) with unintended consequences.

3. Two paradigms

Two paradigms can serve to illustrate the relationship between a technology, its affordance, and a practice. The first, which I call 'a square peg in a round hole,' describes the problem of adapting a new technology to a current practice. As the new technology is introduced into the practice, a dysfunctional relationship can develop between the tools and a task. This occurs either because the task is poorly understood or because the process of displacing a traditional technology is largely one of the substitution of tools—ones with the wrong affordances. This inappropriate use of the technology results in a poorer practice. An example of this was readily seen in the early uses of CAD tools in the design process, where they introduced false rigor and instilled misplaced confidence in what was, at best, tentative design decisions. The answer to this dysfunction was to 'round off' the square peg—making tools that better fit the (perceived) needs of the practice.

The second paradigm, which I call 'the horseless carriage,' is characterized by the shifting perception of a practice as it transforms in relationship to a new technology. In using the term 'horseless carriage' to describe the automobile in the early 20th century, the task of transportation was wrongly understood through the lens of a previous technology, not realizing that the practice of travel has changed dramatically. Understanding this paradigm requires asking the question—how do the affordances provided by the new technologies change the design practice and its products? Do we understand how having more precision early in the process affects the reasoning of options? Do we understand how communication via digital media fundamentally changes the culture of a practice? How the emergence of virtual 'places' changes our work, study, and entertainment practices (as well as changes our conception of ourselves)? How does knowledge once invested only in the designer but now ingrained in the tools, effects the practice?

Architects have had only a few decades of experience with computational tools. Therefore it is not surprising that the fit between the affordances offered by computing technology and design practice is still problematic, and its consequences are not yet well understood. But it is already clear that such consequences are significant.

4. Architecture's New Media

In the 21st century, the 'environment' in Environmental Design, more than ever before, will not be limited to the physical environment alone. The digital revolution has augmented, replaced, and 'remixed'—to borrow a New Media term—that which is strictly 'physical' and that which is strictly 'virtual.' Over the past two decades we have become accustomed to communicating, shopping, conducting business, being educated, and being entertained in an ever more transparent mix of physical and virtual environments. Our physical spaces are becoming more 'aware' of our human presence and activities, in ways that range from doors that open automatically when we approach, to elevators that position themselves at the most heavily used floors, to surveillance systems, 'smart' homes, and 'intelligent' roadways. The materials from which we build physical environment have become more sophisticated, not merely in their physical properties, but also in their ability to respond and adapt to changing conditions. And communication tools like the Internet, coupled with object-aware (rather than graphics-aware) databases are changing the way Architecture is practiced. No

longer is a small architectural office limited to practicing within a radius of 100 miles of its physical location: it is now commonplace to collaborate on projects located on other continents, with partners spanning the globe, in a design practice that spans 24 hours a day.

5. The impact of computing on architectural education

At the dawn of the 21st century we are faced with unique environmental, economic, social, and political challenges, such as global warming, globalization, diminishing natural resources, and aging populations. At the same time we also have at our disposal opportunities such as ubiquitous information technologies, new materials and building practices, new learning methodologies, and a knowledge-based economy. Addressing these challenges and opportunities requires new approaches to education in general, and environmental design education in particular. While traditional values, methods, and practices are still important, architects, planners, and landscape architects who will practice in the 21st century (much like other professionals) need to know more, about more issues, than ever before. They will need to have a better understanding of the impact that diminishing natural resources will have on physical, social, economic, and political environments; the means they can employ when designing new environments; and the new kinds of products they will be asked to design. More importantly, they will need to understand the impact these developments will have on their professions, on the global environment, and on the societies they serve. Faculty and students will have to assume a leadership role in research and design that will direct these developments along social, cultural, and professional values.

Schools of architecture, therefore, have the responsibilities of understanding these changes, and guiding them, while educating new generations of architects who will use these methods, tools, and practices to change the environment in which we live. That is our challenge, as educators and researchers. If we don’t rise to meet it, others (such the vendors of CAD tools) will, and shape our discipline and our environments for many years to come. Understanding the implications of these new affordances requires a new approach to architectural education: an education that views the changes from the point of view of the horseless carriage, rather than the square peg in the round hole.