The (changing) roles of computing in architectural design and education

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The evolution of computer-aided design in architecture can be viewed as the search for technology that can fulfill certain pre-conceived roles, or it can be viewed as the search for the most appropriate role, or combination of roles, that technology can play in the architectural design process.

The first view sees architectural design as the driving force behind a technology struggling to meet the needs of a profession. Beginning with the need for more powerful computers that can handle complex geometrical operations, for high resolution graphical input and display devices, and for methods that can accommodate very large data sets, the needs of CAD have always been one step ahead of prevailing technological solutions. Since Ivan Sutherland’s famed SKETCHPD program, CAD was directly or indirectly responsible for the development of computer graphics, minicomputers, and input devices we now take for granted. And while those developments have found use in many areas, CAD continues to set the goals for computing technology: solving such problems as simulating the dynamic behavior of buildings, the movement of people and the natural environment will continue to require not only more powerful computers, but also new methods for managing the data.

It is, however, the second view which should be of greater interest to the profession and discipline of architecture, possibly even to society at large: the search for the roles that technology can play in the architectural design process may actually change how the built environment is conceived, constructed, and used, because computers, much more so than any other tool, have the power to change the tasks they are applied to, creating new roles for themselves along the way.

Design tools

The first and most obvious role computers have assumed in the design process has been as tools: instruments with no intelligence or volition of their
own, that can augment the abilities of an experienced designer, making the execution of some specific task more efficient, more precise, or more effortless. Drafting and modeling tools are examples of computers fulfilling this role: they replace traditional paper and pencil with electronic implements, but do not fundamentally change the task of drafting or modeling. The designer must still instruct the computer to draw each line, construct each object, change its color, and position the viewpoint. The computer, much like paper, does not ‘understand’ the evolving design. It cannot comment on its qualities, nor does it ‘know’ when the architect has made a mistake.

Like other instruments, such as telescopes and microscopes, computers can help designers see what cannot be seen by the naked eye: they can ‘visualize’ buildings that do not yet exist in as much realism as desired. In that capacity they go beyond drafting and modeling tools, because the visualization can reveal details and nuances that formerly only a very talented artist could draw.

In a more advanced state of their role as tools, computers can function as measuring instruments: light meters, thermometers, accelerometers, and more. In this capacity, they can collect data from the model and convert it into measures of light levels, temperature maps, and display of winds patterns around tall buildings. Still, they function only at the direction (and discretion) of the human designer. Furthermore, the information they provide must be interpreted by the designer then, put into action by him/her in the form of design changes.

Another role of computers as design tools is provided by their communication abilities: by connecting individual computers through communication networks, like the Internet, they allow members of the design team to share information quickly and efficiently. And since buildings have long been the result of joint efforts of many specialists who must coordinate their individual contributions to the joint enterprise with one another, these communicative abilities are as important to bringing the building project to successful conclusion as are the contributions computers have made to supporting individual designers. Moreover, their processing abilities allow computers to be active means of communication, rather than simply dumb conduits, like telephone and fax machines. They can, for instance, help assure the proper distribution of design information, track changes proposed by individual members of the design team, and enforce access and version control.

Tools, of course, have a glorious and important role in the advent of civilization, and their importance and impact on the design process must not be underestimated. Still, their ability to affect a qualitative change in the task they are applied to is limited by their need to be activated and supervised by their human operators.

**Design assistants**

To go beyond the limitations imposed by a human operator, tools must be infused with intelligence and volition of their own. Administrative assistants, travel agents, and stock brokers provide a service that cannot be matched by mere tools: they are able to take a general instruction, fill-in missing details, negotiate obstacles,
find alternatives, and present the results of their action in a processed form to their ‘masters.’

Computers have the capacity to become such assistants. In the design process, the role of computational assistants may be likened to that of a junior designer who can take generic instructions such as ‘design a staircase between these floors’ and carry out the task without further intervention by the senior designer. They could elaborate details, watch out for known problems, and resolve them. They could answer questions submitted by less capable tools, and supervise their operations.

In their capacity as design assistants, computers would relieve designers from the need to perform mundane tasks, and augment their ability to supervise complex projects. Of course, the boundary between ‘interesting’ and ‘mundane’ must be negotiated between the design partners, human or computational, much like it is being negotiated today between human designers in an architectural office. The same task may appear more ‘interesting’ one day, deserving the full attention of the human designer, and less so another day, when it is relegated to the computer assistant.

By endowing computers with the intelligence necessary to carry out complex tasks and the volition to do so on their own, computers can go beyond the abilities of their human operators. Their unlimited patience, infallible memory, and enormous speed may help them develop interesting and novel design solutions, find answers to baffling questions, and contribute to the development of new knowledge.

**Design environments**

The inability of computers to comprehend any design activities that are not done within the computational environment itself, hence the need to design ‘in’ the computer, had the unintended but critical effect of transforming the computer from a design ‘tool,’ in the traditional sense of the word, into a design environment: a ‘place’ where design occurs. Instead of following the designer, like a pencil does, allowing him/her to design wherever and whenever s/he likes, computers force designers to ‘come to them.’ Consequently, designers must fiddle around with all sorts of knobs, switches, and gadgets to set the machine up so it can begin to support the design activity and, in general, constrain the designer and shoe-horn him/her into the machine’s environment.

By becoming the environment where design occurs, the computer has changed the culture of the design profession. In the early days, when computers were too expensive to sit idle, designers had to work in shifts—a most unnatural imposition on the oft intuitive and serendipitous process of design. Later, the addition of Internet communication abilities has extended their design environment to encompass not only the individual designer, but also other members of the design team: the manufacturers of the objects that are used to assemble the design, the clients, the public, and other interested parties. It has contributed to creating a global design environment, diminishing the importance of co-location, and transcending time zones. The consequences are better integration of the various parts of the
design, but also the need to accommodate the schedules and work habits of others, control the flow of information, and sometimes the loss of ownership over the final product.

**Habitable physical environments**

Changing the culture of the design profession by placing it within the domain of the computer is, however, only the first of three emerging effects of computers as environments. The second effect—computers as inhabitable physical environments—has been envisioned by the Architecture Machine Group at MIT in the early 1970s. In its 21st century incarnation, the vision of inhabitable environments infused with many computational devices has taken the form of computer controlled temperature, humidity, and lighting, security systems, elevators and doors, even electronic building ‘skins,’ creating seamlessly networked and ever-changing electronic landscapes. The typical automobile now sports some 26 individual computers, controlling everything from fuel injection to temperature, traction to air bags, brakes to pre-tensioned seat belts. We expect the door at the supermarket to ‘recognize’ us and open for us as we approach, and are becoming accustomed to the presence of ever-vigilant security cameras, tied to automated face recognition systems in airports and sport stadia. Public pay phones have lost their cache because a wireless communication device, which can deliver not only sound but also text and video messages, to the point where we no longer know where, now connects everyone or even when, the target of our phone call is.

The diffusion of computers into our everyday environment has the effect to making the environment more ‘intelligent’—at least more cognizant—of our presence and activities, and enables ‘it’ to take action on our behalf. Such actions can be based on simple feedback loops, such as the control of temperature through a thermostat; or it can be model-based, such as scheduling elevators to meet the needs of rush hour traffic in an office building based on expected activities, rather than evident ones.

**Virtual environments**

The third, and potentially most radical effect of computers assuming a role of inhabitable environments, is the advent of Cyberspace—a term coined by William Gibson to denote the information space created by the Internet—and its steady assertion of itself as a ‘place.’

Although it can only be accessed through the mediation of computers, and can only be inhabited by proxy (i.e., avatars), Cyberspace is fast becoming an extension of our physical and temporal existence, offering a common stage for everyday economic, social, cultural, educational, and other activities. Unlike other networks that preceded it, like the telephone network, Cyberspace has become more that just another means of communication. It has become a destination in and of itself: we shop ‘there,’ are entertained ‘there,’ and get educated ‘there.’ To re-quote Gertrude Stein, “There is a there there.”

Making places for human inhabitation in a non-physical space raises interesting questions concerning presence, authenticity, adaptability, orientation, and suspension of disbelief. What kind of
activities can be supported by non-physical spaces? What will it take to support them in a socially and psychologically appropriate manner? Already video conferencing, e-commerce, and video-entertainment are migrating to Cyberspace, leaving behind the traditional Agoras, Bazaars, and Amphitheatres of the past. The new ‘space’ is virtual, the construct of computers. But we humans have not changed, nor have our relationships with other human beings. The opening of a new kind of space made possible by computers and networks promises to revolutionize our perception of reality like no other invention before it, and challenges the professions of architecture, town planning, and interior design that have been striving to make places that accommodate human activities in the physical domain for thousands of years.

The roles of computing, with regard to Architecture, are thus multifarious, with varying degrees of impacts. They range from tools that can augment certain traditional design activities, with little impact on the activities themselves, to more pervasive (and invasive) impacts as environments within which design and even habitation itself occurs.

The changes are occurring very rapidly, compared to the sedate pace of past evolutions in architectural design, thus shaking the foundations of the profession as no other invention has done before. Not even the invention of scale drawing in the Renaissance, which established the profession of architecture in the first place.

Our role as ACADIANs is to discover, interpret, and communicate these changes to our students, so they will be better prepared to function as architects in the brave new world this technology is making for them.