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Contemplating the Evolution of the Profession in Light of Emergent Technological Practices

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Architects understand that it is crucial to carefully consider the context in which a design proposal is situated, but they would be well served to offer the same level of scrutiny to the ever-changing context of their own profession. Fortunately, the start of this debate is ubiquitous within it; in a profession that thrives in agitated discourse, few subjects can ignite such controversy among architects as the subject of "hand drawing" and its value to the profession. The contention is often pronounced and reactive, to be passionately debated in architectural offices, academic conferences, and online forums. Opinions formed during the architect's education may remain entrenched, dividing along generational lines; those who lament the loss of the hand drawing, from the loose sketch to the fine pencil rendering, and thus the bulwark of character and tangible craft within the profession, clash with others who assail this group's anachronistic inefficiency and nostalgic longings in the face of unstoppable progress. Still others will generally agree with the value of learning those hand drawing skills, but simultaneously concede that the computer has become the dominant method of production.

Sometimes blame for the loss of hand drawing may be directed at academia, as if the schools were responsible for changing the operative mode of the profession. This misinterpretation is ironic, as schools followed the lead of industry in the conversion from manual drafting to CAD systems. It is interesting to note that the extensive refashioning of architectural offices from manual to computer-aided drawing facilities at the very end of the twentieth century was generally implemented by management who had little or no operational experience with the new technology. The change was ordered by the older generation of the profession, the partners in their fifties and sixties, who realized that the efficiencies and economies of scale associated with CAD production demanded implementation in order for their firms to remain competitive. These efficiencies demanded a different set of skills (i.e., the ability to letter with "E" type lead was replaced by the ability to x-reference into paper space) with which the managers were personally unfamiliar. Certainly the schools influence the profession, but it is the market forces of the workplace and capabilities of individual workers that primarily drive the methods.

This is not the first time that changing times and technology have elicited fundamental changes within the profession. From the invention of constructed perspective drawing in the Renaissance, to the introduction of the reproducible blueprint machine, to the introduction of digitally-enabled workflows, practice has fluidly adapted to the demands and opportunities presented by technology, knowledge, economies, and culture. The emergent transformations are not the product of prescription by an elite but instead a paradigm shift of consensus; individuals experimenting and calibrating their own specific projects have reached similar conclusions, thus collectively steering the evolution.

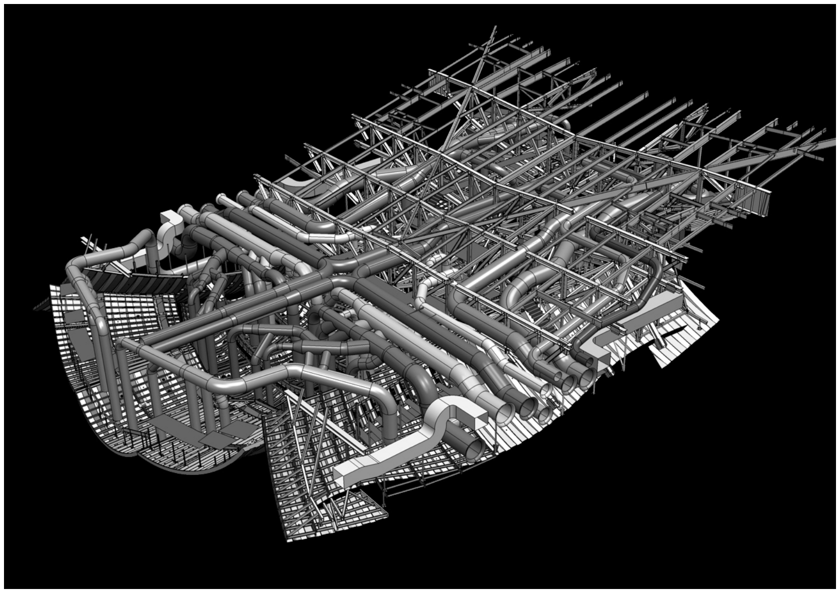
From "Macro-" to "Micro-": The Rise of the Information Society

The practices of the profession have been molded by the technological, economic and cultural transitions of society through the periods that historians have labeled the *Classical* era, the *Industrial Revolution*, and the post-industrial *Information Age*.[1] In this temporal taxonomy, it could be argued that the transition into the new global information-based service economy immediately followed the surge of physical infrastructural expansion in the nineteen-seventies, reflecting increased wealth, production capabilities, and technological facility.[2] High Modernism waned as the dominant architectural mode during this time, as the "Machine Age" (invoked by the Futurists, Le Corbusier, and the Bauhaus group, among others) evolved into the contemporary age of digital information telecommunications (invoked by Diller Scofidio + Renfro, Morphosis, and Rem Koolhaas, among others).[3]

Just as it seemed that the future would yield achievements ever larger, faster, and higher, the energy crisis in the mid-seventies foreshadowed the straining of the planet's available resources. Within fifteen years, the emerging "service economy" within the First World, shored by vastly improved telecommunications capability, would shift the ambitions of developed nations to an engagement with micro rather than macro technologies. The development of the transistor allowed the introduction of solid-state electronics into many aspects of professional and home life; the subsequent development of the silicon microchip reduced the size of this machinery to the microscopic. The pocket calculator was followed within a decade by the personal desktop computer, allowing unprecedented efficiency of numerical and algorithmic calculations within the reach of the masses. The precision and efficiencies of new informational technologies accelerated at a geometric rate, allowing increased efficiencies and precisions within infrastructure in general.

The architecture profession, as always, adapted accordingly, responding in an uncoordinated but emergent fashion to the new web of cultural and technological intricacies; driven by the underlying economic impetus, the digital revolution transformed the way in which architecture was drawn. Now, a new generation of progressive designers is exploring how the exploding computational and communicative powers can to used to further the primary mission of architecture, to create habitable and expressive environments for society.[4] At any moment in time, the collective body of practice is constantly shifting, calibrating itself in accordance to a new series of demands. These "evolutions" or "mutations" (a term used by Rem Koolhaas to describe the role of these emergent effects on large scales, that of cities) indeed take root at the lowest level: the individual practitioners and offices. Individuals strive to capitalize and protect their status (and that of their firms) by acquiring new skills and knowledge. In the past, this may have involved lettering techniques

Detail, Walt Disney Concert Hall, designed by Frank Gehry. Metal panel fabrication by A. Zahner Company, Kansas City. State of the art construction technology at the turn of the millennia.



Catia screenshot, Courtesy Gehry Partners

or Beaux-Arts rendering styles. In the early twenty-first century, opportunities include learning 3D software or acquiring LEED certification.

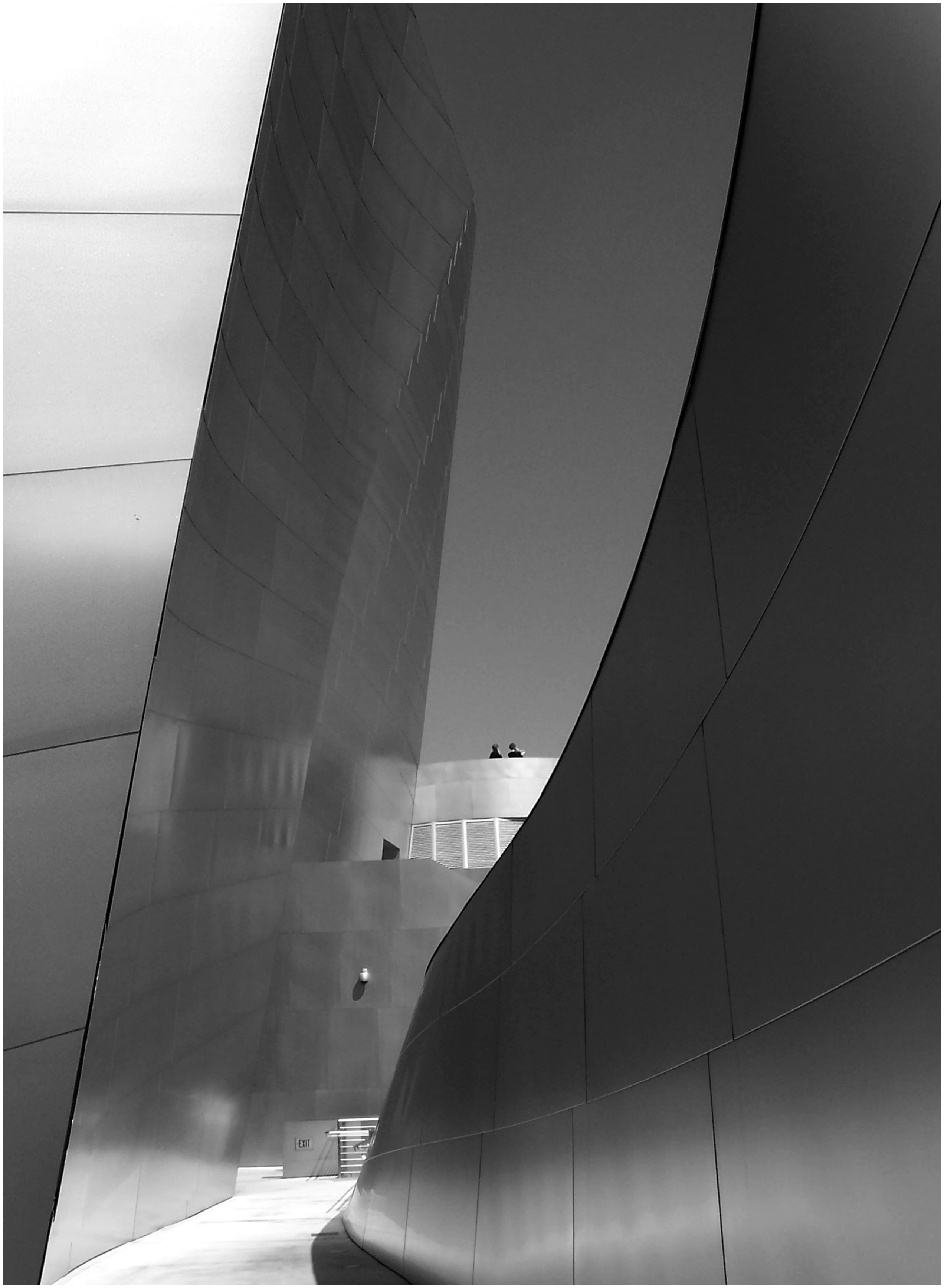
Evolving Modes of Design Visualization and Fabrication Technology

So much of architecture praxis has been about the production of visual mages and documentation that there exists a subset traditionally called "draftsman" within the "architectural profession." In recent decades, this position has largely been replaced by the "CAD operator." Now there is talk about superseding the terminology of CAD (*Computer Aided Design*) with that of BIM (*Building Information Modeling*) in order to more accurately represent the changing role of the technology.[5] The subset of BIM specialist holds crucial potential within future emergent practices, for reasons to be discussed below. It transposes the practice of the architect into a different mode of visualizing, utilizing efficiencies and precision made possible by advances in informational technology.

Architecture, like so many other industries, is becoming increasingly focused and dependent upon rapid information transfer. The advent of "intelligent" object-oriented software now referred to as BIM exploits the potential of digitally centered design. This highly specialized technology fundamentally alters the representational working methods of architects by creating a virtual model that contains an enlarged set of data about the design. Architects have always been information organizers; traditionally the information to construct a building has been relied via a series of line drawings and text arrayed in the sheets that comprise a set of documents and their accompanying specifications. In the end product, the success of the arrangement in three dimensions has traditionally depended upon the architect's ability as a draftsman to transpose those ideas into plan and section, even if it was initially designed in model or perspective. In this process, he or she must provide all information required by the contractor to construct the building, including cross-referencing within the set.

BIM automates much of this transposition, so that the conception of the built object occurs within visualizations that dynamically depict three (or even four) dimensions, and from this virtual model the computer assists in extracting a document set that can then used to construct the built artifact. Efficiencies claimed by proponents of BIM include optimized workflow, information transfer streamlined between various design and construction teams, and improved error checking and conflict detection; the summation of these results in shorter project duration and reduced costs.

In this process, the representations of the design are integrated with networks of accompanying data, thus bypassing the traditional chasm between "rendering" and "construction document set." Databases that were traditionally transcribed manually, such as window and door schedules,



are extruded from the three-dimensional virtual "model" automatically and in real time. As generic features of the design are replaced by proprietary components during the design process, the rendering is automatically updated. Sections and elevations may be generated automatically from the model and updated in real time with same ease as the plan. The conveyance of this information streamlines parametric delineation, allowing the designer to test multiple proposals and refine the aesthetic of the building multiple times in a shorter amount of time.

Although in 2007 only 10% of firms utilized BIM for their design and production tasks,[6] the persistent pressure for efficiency and profits seems likely to increase its demand in the future. The highly specialized technology requires significant training and complex non-linear thinking, but the burgeoning ability to transfer information to automate construction methods, as in rapid prototyping, will reframe the design process and the use of drawings. Innovative architects such as Frank Gehry are utilizing and even developing this technology for the design and fabrication of building components; however, in general its application in architecture trails that of other industries.[7]

Virtual Prototypes and Transparent Interfaces

Aerospace and automotive industries have been using streamlined digital design and fabrication for decades. The prototype of the Boeing 777 (which entered service in 1996) was in fact "virtual"; the CAD system utilized solid modeling for every component of the aircraft's design, so that the components were "fitted together" and tolerances tested within the computer "model" itself, saving millions of dollars for the production of the traditional full-scale prototype.[8]

The utilization of these "virtual spaces" has reached such relevance that a profession that claims expertise on "space" should no longer ignore it. The online site Second Life has demonstrated the viability of virtual "places" as environments for various and widespread cultural interactions (such as economies, social relationships, and entertainment) through mechanisms that allow millions of users to interface and even partake in user-driven economies in computer generated lands through their PCs.[9]

The increased connectivity of the global communication networks allows rapid interchange of information and images within applications such as YouTube and instant messengers. Headsets and gloves used for experiential immersion in a virtual environment offer the most transparent view into virtually designed spaces yet, presenting opportunities for the designer to experience space via a simulation of the proposed building. As the BIM capabilities become streamlined with these various virtual interfaces, the change in work methods may be profound. Architect and client will not need to be in the same room in order to discuss the project. Instead, they could meet "virtually" within the proposed digital model of the building. This virtual walk-through, with real-time photorealistic projection within the virtual gear, would allow a simulated experience within any part or variation of the building within time, allowing any number of options to be rapidly tested. For example, if the client wished the window to be higher, the architect could raise through a voice command, pointing or other sign language, or any other intuitive interface to be developed.

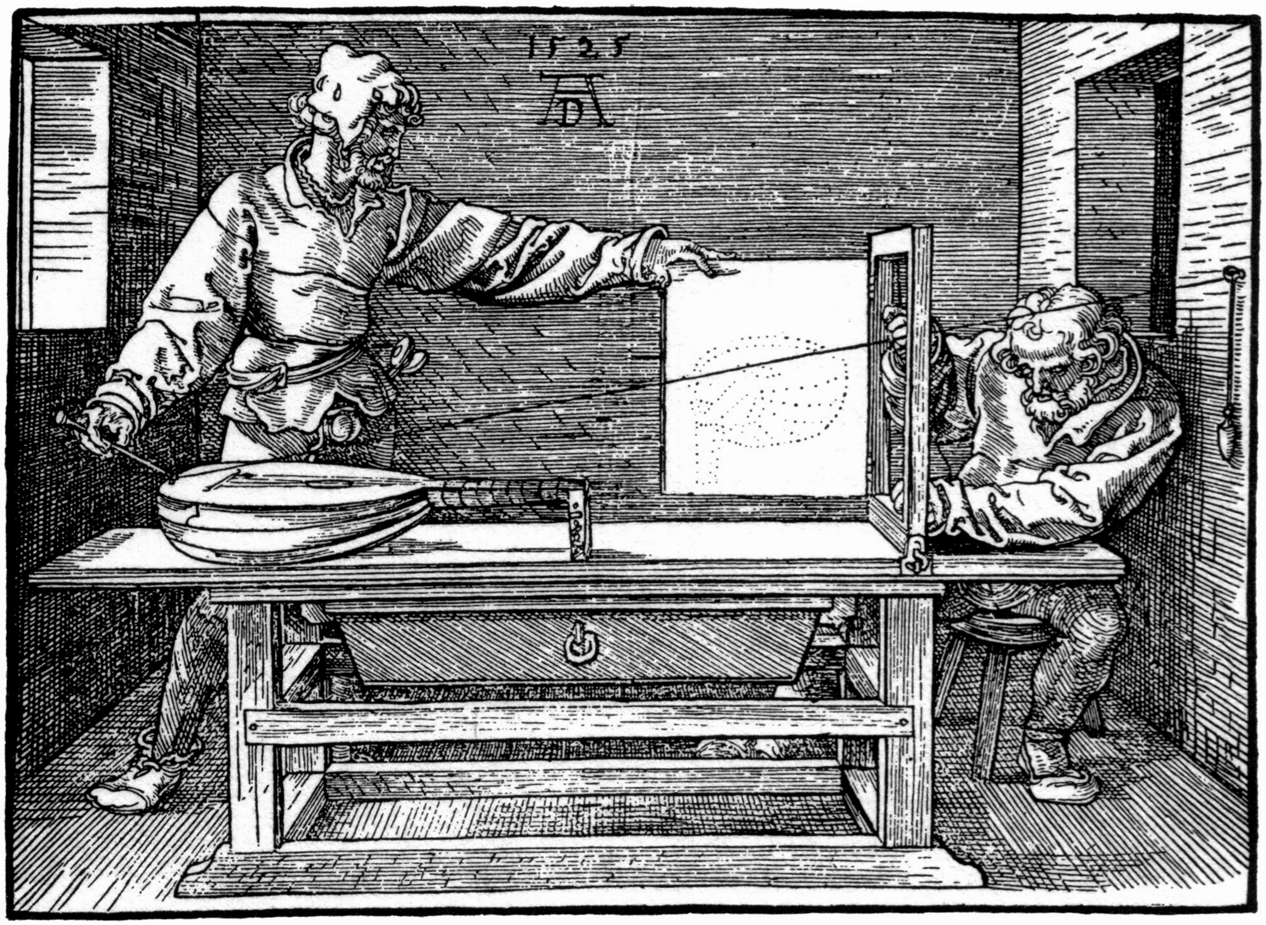
All representational technologies require an input to manipulate the medium, whether it be pencil, pen, mouse, or retinal tracking device. The media offer paths of greater or lesser resistance to each parameter of the interface, challenging the designer to negotiate in the quest to productively translate concept into form. The orthogonal geometries associated with the parallel bar and right-angle triangle offered Beaux Arts architects both determinism and resistance in their process, just as the virtual manipulation of complex NURBs surfaces influences contemporary designers. Major differences result from the "transparency" or resistance of specific operations. One of the strengths of hand drawing is the tactile quality, the direct effect of the hand's movement upon the graphic marks. The mouse, as an input device, has been more troublesome in this aspect, but emerging technology such as multi-touch interface screens, voice recognition, gesture recognition and 3D virtual sculpting apparatus promise more intuitive engagement for the user.[10] Although architects usually do not consider a pencil as an "interface," this view may be productive when thinking about the processes of representation and design.

Advancing toward Auto-Obsolescence?

Speculation about architecture's future cannot take into account the myriad influences that will emerge in a nonlinear fashion. Just how much will automation reduce the workforce? How will open source technologies influence the processes of the design profession? Will architecture even be necessary or viable? Is it possible that computers may be able to take over all design tasks, leaving architecture as an obsolete profession?

An examination of census records from a hundred years ago reveals a swath of occupations relevant at the end of the industrial revolution, many of which have since faded into obscurity.[11] Some of these, such as "telegraph messengers" have since been rendered obsolete outright by technological advances. Others, such as "boiler washers and engine hostlers" are no longer considered to be an occupation in themselves; while boilers are still constructed, maintained, and cleaned, these activities have been subsumed by other professionals and tradesmen, such as engineers, mechanics, and janitors, respectively.

Searching further back in time, previous centuries reveal hundreds of



Introduction in the Art of Measurement with Compass and Ruler, *woodcut by Albrecht Dürer, 1525. State of the art representational technology in the sixteenth century.*

professions that no longer exist. From the "*fuller*" (one who trampled cloth) to the "*fletcher*" (arrow maker) to the "*furber*" (furbisher of armor), many of the activities that were integral to society have been made redundant or unnecessary by the changes in societal structure.[12] In most of these cases, these changes were due to the changing application of technology.[13]

It is conceivable that the profession of "architect" could eventually fold into some other role. The fate of the profession will likely be integrally tied with the future form of civilization; a catastrophic collapse of society would be one fundamental shift, but as long as civilization survives, there will be the necessity for shelter and the built environment. However, if technology advances to the state where a supporting work force is unnecessary to satisfy demand, possibly because of automation or conflation with another profession, then architects will no longer remain relevant as an occupation. Hopefully this would happen slowly enough that the phase-out would be generational, similar to that of the furbers and fletchers, rather than a situation of rapid unemployment.

The Work of Architecture In the Age of Rapid Information Transfer

The historical skill set of architects may evolve to the point they are no longer recognizable using the present terminology. There exists the possibility that automation will ultimately replace the human role in architectural design. The work of creating spaces and environments may shift into some other realm that cannot yet be imagined and is no longer considered to be the volition of the architect as artist; there have been suggestions of biomorphic arrangements, combining biology and engineering in creating algorithmic environmental solutions. In the face of obsolescence, will architects understand their role and move aside without nostalgic remorse? Or will they engage in "obsolescence management" to ensure their ongoing relevance?

The discussion about the relevance of "hand drawing" is the start of an examination of these issues. Architects who realize that the computer is central to the workplace for the foreseeable future can strive to make its processes more transparent, like those of hand sketches. Those who lament the supposed impending disappearance of hand drawings can take heart in the unpredicted endurance of other supposedly outmoded media.[14] Walter Benjamin, who cast light on the relationship of technology and culture, talked about the "cult value" of art objects, and how the desirable quality of this unique "aura" separates the traditional media of painting from the newer reproducible media of photographic or filmic art pieces.[15] This same uniqueness may be ascribed to a hand drawing, and this value is recognized by the general public. As long as paying clients perceive this value, hand drawing will remain a part of the profession. However, like the skills of carving arrows and knitting chain mail, these skills will likely recede from the mainstream to become those of the hobbyist or enthusiast, and this too will be the result of the ever-changing context in which we live, work and design.

Notes

1. See sociologist Manual Castell's trilogy *The Information Age: Economy, Society and Culture, volumes I, II, and III* for an extensive discussion on information flows and network society. Cambridge, MA; Oxford, UK: Blackwell (1996, 1997, 1998).

2. There are an extensive number of physical superlatives relating to this period's technology. The only supersonic passenger airliner was in service from 1976 to 2003 before its extraordinary fuel consumption rendered it commercially unviable. The most powerful rocket system ever produced, the *Saturn V*, flew on missions to the moon from 1967 to 1973, to be later replaced by the much smaller but reusable low-earth-orbit Space Shuttle vehicle. The infrastructure of the world's cities realized comparable ambitions in those decades, as highways expanded and buildings became taller and larger. The World Trade Center was completed in 1972, but its twin towers remained the tallest in the world only until the Sears Tower was completed in the following year.

3. As is often the case, the architectural theory of the 1970s was largely outpaced by current events; in the United States, the collectively dubbed New York Five (Graves, Eisenman, Gwathmey, Meier, and Hedjuk) advocated an Architecture of autonomous logic rather than contextual or performative motivations. They initially drew inspiration from formalities of early twentieth century compositions, the International Style, the Bauhaus, and concurrent movements, which were all essentially descendants of abstract painting styles such as *de Stijl* and Cubism. Ironically, the predominant architectural style of the following decade (the 1980s) largely stemmed from historicism, and was even less relevant to the technologically induced upheavals of the time.

4. Just as the earlier architects of Modernism seized upon both the aesthetics and modular efficiencies of industrial output within the deployment of form and function, the use of computational power and digital fabrication is allowing designers to realize highly complex forms. William Mitchell of MIT proclaims that the "*replacement of drawings done by hand with 3D CAD models and computer visualizations has removed ancient constraints on architectural geometry and is allowing exciting new languages of architectural form to emerge. The use of sophisticated analysis and simulation algorithms, as well as accurate calculations that take advantage of abundant compute power, allows the behavior of these new forms to be understood and predicted.*" Science Magazine, Vol. 285, Aug. 6, 1999, p. 841.

5. Jerry Laiserin's argument in 2002 for the BIM terminology (which can be read at *http://www.laiserin.com/features/issue15/feature01.php*) articulates much of the reasoning for this shift.

6. The usage is significantly higher for larger firms; half of those with 50 or more employees were using BIM for billable projects in early 2006. *Architectural Record*, April 2007, p. 155, quoting the AIA survey *The Business of Architecture*.

7. Frank Gehry currently operates two firms, the architectural service firm *Gehry Partners*, and the building and construction technology group *Gehry Technologies*. The latter recently released the BIM software *Digital Project*, in collaboration with ARUP, as a holistic program design platform for entire life-cycle analysis. SOM recently invested in this package, signaling confidence in its architectural application. *www.gehrytechnologies.com*.

8. These cost savings, compared to previous similar aircraft development, reportedly included elimination of over three thousand assembly interfaces, a reduction in engineering change requests and material reworking by ninety percent, a 50% reduction in cycle time for engineering change requests, and a fifty-fold improvement in assembly tolerances for the fuselage. For more information, see *www.cds.caltech.edu/conferences/1997/vecs/tutorial/Examples/Cases/777.htm*.

9. The virtual world of the highly popular MMORPG *Second Life*, developed by Linden Labs, boasts a population of 6.7 million "inhabitants" (registered online users) as of May 26, 2007. Its currency is the Linden Dollar, which can be traded on the online exchange (a component of the site *www.secondlife.com*) at the rate of 266 Linden Dollars to one U.S. Dollar, at the time of this writing. Most of the monetary exchange occurs between the inhabitants for virtual goods, services, and real estate that only "exist" within the context of the simulation.

10. For an excellent primer on various input devices, their history, and their advantages and disadvantages, see the article by Bill Buxton of Microsoft Research; it can be read online at *http://www.billbuxton.com/multitouchOverview.html*. Buxton has been involved with the development of this technology for three decades, and has compiled a thorough directory of input device information, available at *http://www.billbuxton.com/InputSources.html*.

11. The *1901 Census of England and Wales Online* reveals that the majority of the citizenry were in occupations directly involved with industrial production or infrastructural activities. A typical page, selected at random, listing ten of the citizens enumerated as "William Smith" at age 38 reveals "coachman domestic," "brass finisher," "bricklayers laborer," "warehouseman," "carpenter," "engine man blast furnace," "cotton weaver," "coachman domestic," "bricklayers laborer," and "metropolitan police constable." *http://www.1901census.nationalarchives.gov.uk/*

12. For these and additional examples of historical occupations, see *http://olivetreegenealogy.com/misc/occupations.shtml*.

13. For example, both the *fletcher* and *furber* cited above suffered economically from the advent of the gunpowder-enabled firearm, which drove a profound shift in the balance of power in conflicts through marginalizing the effectiveness of both armor and archery. While the technology of both have survived and evolved in accordance with their new applications (for example, contemporary sport bows and main battle tanks both employ highly advanced material technology) the means of production is longer central to society as in centuries past. The skills of producing feathered arrows and weaved chain mail now exist only in a highly limited circle of individuals who impart a value upon this antique knowledge. These examples may illustrate how technological shifts manifest within the labor force.

14. There are numerous examples of obsolete technology that did not disappear. The Internet has not killed the traditional book, which is still prevalent in bookstores and libraries. The invention of the CD caused the sale of albums and cassettes to plummet, but now vinyl has made a comeback with enthusiasts, who value its unique qualities. It seems likely that the computer will not kill hand drawing. In fact, architectural hand drawings can be readily sold for monetary sum as art pieces, while digitally created drawings of the same subject matter have considerably value in the marketplace.

15. Walter Benjamin, "The Work of Art in the Age of Mechanical Reproduction," 1937, translated in *Illuminations*, New York: Schocken Books, 1969.