Kristine K. Fallon, FAIA

The AEC Technology Survival Guide

Managing Today's Information Practice

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MANAGING TODAY'S INFORMATION PRACTICE

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PREFACE

Just as this book was going to press, Ken Burns was interviewed about his new documentary film on Thomas Jefferson. "At the end of the 18th century," he said, "it was possible to know everything." How the world has changed in 200 years! In this century we entered an Information Revolution that floods us with as much raw data in a day as Thomas Jefferson tackled in a lifetime, and that places in our hands the tools to continuously remake ourselves and our businesses.

This explosion of possibilities demands constant attention and energetic, creative response. Principals of design and construction firms are finding themselves in a dilemma: managing information technology is taking more and more of their time and operating budgets, and they are becoming increasingly uncomfortable with their lack of IT expertise. One of my consulting clients remarked that he felt like he had two staffs: his human staff, who required recruiting, mentoring, encouraging, motivating and training; and also a machine staff, which required attention to its selection, configuration, upgrades, maintenance and networking. A sole proprietor commented on feeling at the mercy of the firm's CAD-capable employees.

Both these principals were articulating the emerging reality: information technology has become a major business cost and a critical component of business process and strategy. Its management cannot be ignored or delegated to junior personnel. Principals can no longer afford ignorance. They must lead the deployment of information technology within their firms. But how—if they are not comfortable with their own technical competence?

The easy answer is to recommend that firms hire competent IS managers and/or consultants and take their advice. But more and more top managers realize the importance of assuming personal leadership in this aspect of their businesses. If the experience of other industries can serve as an example, only AEC organizations whose top managers exhibit commitment and leadership in the application of information technology to the business will achieve competitive advantage through this technology.

The *AEC Technology Survival Guide* tackles this management problem head-on, suggesting techniques, tools, options and decision-making structures to help design firm principals seize control of their firms' technological destinies while, at the same time, taking maximum advantage of the specialist skills resident within their staffs. Its focus is on organizational effectiveness, not technology components.

I have attempted to be extremely rigorous in selecting the information presented here. Although the focus and attitude of this book is influenced both by my years of selecting and managing technology within design firms and by the broader exposure to many AEC organizations gained through computer consulting, I have sought additional validation for the concepts presented. Beyond looking at general business studies and experience in other industries, I have interviewed and cited the experience of design firms of all sizes—from the very smallest single-discipline firms to the largest design/build organizations. I am convinced that the guidance offered here is broadly applicable and scalable to firms of any specialization or size within the AEC industry.

Chapter 1, "The Information Revolution," makes the case for taking the current climate of change very seriously. The premise is that the Information Revolution is rapidly and radically transforming life and work. This change will create fabulous opportunity for those with the courage, vision and energy to seize it, but there will also be losers. No one and no business will remain unaffected.

Chapter 2, "Work Organization: Reengineering and Total Quality Management," describes how information technology is inseparable from two of the most compelling and effective management concepts of our day. It draws on the experience of AEC organizations to illustrate real-world implementations and real-world benefits.

Chapter 3, "Reaping Information Technology Benefits," asserts that information technology can and should be much more than a cost of doing business. It describes IT approaches that have yielded measurable benefits for design firms and stresses the need to rethink business practices and address the total design/construct process.

Chapter 4, "Information Technology Strategies for Design Firms," discusses specific classes of technology products and how they fit into business

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strategies. It culminates with a look at the leading-edge, high-reward strategy at one the world's largest firms.

Chapter 5, "Training That Works," discusses the importance of training in a world of lightning-fast technological and business change. It discusses a variety of training audiences, approaches and delivery methods and lays out the *who, what, when* and *how* of effective technology training for design firms.

Chapter 6, "Controlling Information Technology Costs," is a quick, management-level review of proven techniques for controlling, but not eliminating, information technology support costs. System managers may find it lacking the prescriptive, product-specific how-to information they require to implement the recommendations. But this chapter is designed, rather, to provide a management briefing on the issues to consider and the questions to ask the IT staff, not a systems management manual.

Chapter 7, "The Outsourcing Option," describes the potential benefits to and problems of design firms' outsourcing of information technology operations. Increasingly, some amount of IT outsourcing will be a component of virtually every firm's operations, but outsourcing must be undertaken thoughtfully.

Chapter 8, "Tools for Management," provides some self-help tools for answering the questions:

> Are we making the best use of our information technology budget?
> How can we tell whether we're spending too little or too much?

The techniques of content analysis and benchmarking can be used to gain objective views of market direction and industry best practices.

Chapter 9, "Where Have We Come From?," provides a history of computer use, especially in design firms. Most published computer histories focus primarily on the fabulous series of inventions that have kept prices dropping and capabilities soaring over the past 50 years. A few have focused on the extravagant personalities who made the PC industry what it is today. SIGGRAPH has collected extensive firsthand accounts of the history of computer graphics. But what I wanted to explore was how design organizations have *applied* computers to their practices over the years. In addition to published sources, therefore, this chapter relies on personal recollection and interviews to piece together a sense of the range of computer applications attempted by design firms before PCs and off-the-shelf software were available. This view is, by its nature, incomplete and subject to the imprecisions of human recall. But it gives indication of some very interesting threads that, for the moment, appear to have been dropped.

Chapter 10, "Past Forward," reviews the technical and standards developments likely to shape design applications as the decade draws to a close. This chapter is probably the most technical in the book, but principals will want to know the details of the technologies they will be choosing to support their firms' business strategies for the 21st century.

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My greatest debt, however, is to the clients and former employers who provided me with the exposures and opportunity to acquire the experience and insight that are the foundation of this book. These benefactors have been so numerous and generous that I fear any attempt to list them will result in unforgivable oversights. In addition, I thank my family and my teachers for encouraging me to think independently and critically. Finally, I must express sincere appreciation to John Wiley & Sons and my editor, Janet Feeney, for bringing this somewhat unorthodox book to light.

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CHAPTER

1

The Information Revolution

What's going on in our marketplace? How can we be sure our firms will adapt to the constantly changing business environment? Increasingly, our firms are working and competing globally. Facility programs are becoming more complex and entirely new programmatic requirements are arising in response to major changes in our clients' businesses. Clients expect project execution to be flawless in all aspects: quality, budget and schedule. More regulation is being applied to the construction process, in terms of health and safety and of environmental impact. Because of globalization, many of our clients are responding not only to U.S. regulatory requirements but also to international standards such as ISO 9000. Meanwhile, there is more competition, some of it from places such as India, where engineering can be performed at 25% of the U.S. hourly rate. This is leading to tighter design budgets, within which clients are expecting a high level of building system optimization and value engineering. And with all of that, design and construction cycles are being compressed: our clients are demanding that facilities come on line faster and faster, so they can respond to the lightning-fast changes in the business climate.

We are in the midst of the Information Revolution, an economic, technological and social transformation as great as the Industrial Revolution, but happening faster. This revolution is creating profound changes in when, where and how we work, and in our relationship to the organizations that employ us. The basis of wealth is shifting once again—from capital to information. The marketplace validates this assertion: look at the market valuation of Microsoft or the astronomical run-ups in price on the initial stock offerings of Internet-related companies such as Netscape.

In *The Virtual Corporation,*[1] William Davidow and Michael S. Malone put into perspective the pace and impact of change initiated by the Information Revolution. Their thesis is that any technological advance which produces an order-of-magnitude change in some critical measure—how fast a person can get from point A to point B, how much can be transported in a single trip, how many tons of steel a worker can produce in a given period of time, how many people can be killed by one bomb—also produces a revolution in the way society lives and works.

The example with which we are most familiar is the Industrial Revolution. In the 80 years between 1770 and 1850, industrialization increased productivity by about 300%. And we know that the Industrial Revolution changed the world: the basis of wealth shifted from land to capital; work moved from the home or the land to the city; the relationships between people, their employers and their work were transformed; new types of buildings—factories and offices—emerged; and the social status quo was overthrown.

In evaluating the rate of change wrought by the Information Revolution, Davidow and Malone conclude, "Although, strictly speaking, one cannot add all advances together because there would be double counting, it can be said that in forty years computing has experienced a combined improvement in five dimensions—mass storage, reliability, cost, power consumption, and processing speed—of thirty orders of magnitude. Such a level of change is almost beyond human compass. It is equal to the jump from the diameter of a single atom to that of the Milky Way galaxy."[2] The impact of this pace of change is profound, as noted in James Burke and Robert Ornstein's book *The Axemaker's Gift: A Double-Edged History of Human Culture:* "Now, computer-generated knowledge has begun to change the world so fast and so surprisingly that the process comes close to outrunning even our basic evolutionary, adaptive abilities."[3]

INFORMATION EVOLUTION

This corollary effect to the Information Revolution can be termed *Information Evolution.* Essentially, we biological creatures must find a new strategy for using and responding to the waves of information sweeping over us. The earliest and most primitive of creatures have only *reflex* as a mechanism for processing information. Reflex is response to an immediate, present stimulus. If an organism encounters something too hot, too cold or too hard, it withdraws. Next in evolutionary development comes *instinct:* put simply, it does not need to snow for birds to fly south. Instinct involves anticipatory response to recurring patterns of events, rather than to direct stimulus. Our species distinguished itself by its ability to commit information to *memory* and then to draw upon and relate those memories in ways that assist us in problem solving. Memory exists in both the musculature—throwing a spear, playing the piano, riding a bicycle—and the mind—epic poetry, later alphabets, multiplication tables, and so on. Writing was a major step that permitted the externalization and *analysis* of information. From Plato and Aristotle through Galileo and Descartes, Western civilization honed the techniques of deductive reasoning. Descartes (an engineer) concluded in his 1637 *Discourse on Method* that there were absolute, self-evident truths and that all problems could be solved by decomposing them into their smallest parts and solving each individual part through reference to these universal truths.

Western educational systems are based on this reductionist principle. The implicit assumption is that there is a discrete body of theoretical knowledge in each discipline that can be mastered to guide and inform all future work in the field. Since the end of the Middle Ages, however, this approach to information creation has yielded more and more specialized subdisciplines in every category of knowledge, with each specialty becoming increasingly indecipherable to the uninitiated as it develops its own vocabulary to describe more and more precisely the phenomenon it studies. To understand how powerfully this development has progressed, consider that the average member of Shakespeare's audience at the Globe Theater had a vocabulary of about 800 words! By 1982, between 6,000 and 7,000 scientific articles were being written daily and scientific and technical information was increasing at a rate of 13% per year. And that was *before* computers became widely available: the IBM PC was not introduced until 1981. It took from 1946 until 1980 for the number of computers in use in the United States to reach 1 million. By 1983, the number exceeded 10 million! The computer was not the cause of this information explosion, but it has accelerated its pace. In the 1990s, there are more than 20,000 separate technical and scientific subjects and more than 195,000 different periodicals published each year. More information is published daily in *The New York Times* than the average 17th-century Englishman was exposed to in a lifetime!

Our species must now find a new way to process this onslaught of information, and indications are that the new way will be inductive and associative, rather than deductive and reductionist. Many point to the disordered presentation of information on the World Wide Web and the types of navigational techniques, particularly the search engines and hypertext links, that permit information to be synthesized in very new ways. Peter Drucker has defined *information* as "data endowed with relevance and purpose." The next step in Information Evolution—information processing through *navigation*—

will rely on linkages, or connections, to relate data elements in meaningful and purposeful ways.

In addition to turning the human mind toward more *associative* patterns of thinking, Web navigation techniques increasingly depend on a major computational assist. Between 1990 and 1995, the number of Internet hosts—computers that offer access to Internet users—grew from about 300,000 to 5,000,000. Creating and maintaining indices of the Internet's information content is now beyond human capability. Where, then, does the navigational information presented by Internet search engines come from? A type of computer program, called a *Web robot* or *spider*, automatically traverses the Web by following hypertext links and brings in Web documents for keyword indexing. These spiders constantly traverse the Web in order to keep their index databases current. When Internet users access a search engine, such as Lycos, they use a front-end program to enter their keyword(s), which are then used to query the back-end index database. The search results in a list of Web documents, frequently numbering in the tens of thousands, that match the search criteria. For each document on the list, there is a hypertext link to the original document on its home server.

The next step in the Information Evolution is the use of *intelligent agents*—artificial intelligence programs that can learn our preferences and what we *mean* by certain terms, sort through these thousands of documents, and retrieve those that are truly of interest. Such intelligent agents, although not yet in general use, do exist. E-mail filters are available that sort the mail like a good secretary, tossing out junk and categorizing and prioritizing the rest. Many offices have begun to use group scheduling software, which checks the electronic calendars of everyone invited to a meeting to find a time when all are available.

THE INFORMATION ECONOMY

The profound change wrought by the Information Revolution is causing social and economic dislocations similar to those produced by the Industrial Revolution. Lest we be tempted to the Luddite response of condemning the machine, it should be pointed out that the economic reality of the Information Revolution predates the technological reality. In 1956, white-collar workers outnumbered blue-collar workers for the first time in U.S. history. In a study published by the U.S. Department of Commerce in 1977, the author reviewed 440 occupations in 201 industries, identified information jobs and calculated their contribution to GNP.[4] Questionable jobs were excluded, so the study erred on the conservative side. The author defined the *primary* *information sector* as that part of the economy that produces, processes and distributes information goods and services. This sector includes computer manufacturing, telecommunications, advertising, education, printing, and so on. The study concluded that in 1967, 25.1% of U.S. GNP was produced by the primary information sector. The study also identified a *secondary information sector* consisting of information workers employed in noninformation industries and concluded that the secondary information sector contributed an additional 21.1% of GNP. In total, the information economy accounted for 46% of GNP and 53% of earned income—in *1967*—only two years after the first integrated circuit computer was delivered!

What does this mean to our businesses? Clearly, design firms are part of the primary information sector. In the last 20 years, we have seen the cost of a CAD seat drop from over $100,000 to less than $10,000 and movie-quality imaging and animation become affordable for college students. From the limited capabilities of teletype machines, we have progressed through facsimile to almost-free worldwide electronic messaging and document transmittal via the Internet. The combined effects are transforming the mind-set and economics of practice, wiping out inflexible organizations and creating fabulous opportunity for others.

There are a number of facets of this change. The following sections discuss each in detail.

WORK CONTENT

In her 1988 book, *In the Age of the Smart Machine: The Future of Work and Power,*[5] Shoshana Zuboff documents the computer's transformation of work from an exercise of physical skills to one of intellective skills. What the computer has done is to make work processes visible. Zuboff contrasts the *automating* achieved in the Industrial Revolution, which replaced the human body with technology that permitted the same process to be performed with more uniformity and control, with the *informating* effect of the Information Revolution, which automates but also generates new information about the underlying processes so that they become visible, knowable and communicable in a new way. This shift is having a profound effect on the skills required to perform all sorts of work. Physical skills learned through action, and characterized by organic responsiveness to physical cues, are being replaced by abstraction, inferential reasoning and procedural thinking. Of particular importance: a theoretical understanding of the *total* process has become essential. This transformation, this informating effect, has set the stage for *work process reengineering,* which will be discussed Chapter 2.

Zuboff cites a compelling case study of the application of computer-based controls to a pulp and paper production process. The work of process control shifted overnight from slogging in boots through a chemical mist amid huge vats of paper pulp to observing data and process events in a climate-controlled computer room removed from the physical process. This is an extreme and dramatic example, but even in the white-collar world of design consultants we can see parallels: manual drafting and hand-lettering skills highly valued in the past have little relevance anymore. One university professor commented that he sees very different types of students suceeding in the architectural curriculum now than in the past because the basic competencies required by the curriculum have changed so dramatically.

But it is in engineering analysis that we see the informating effect most clearly. Before the computer, engineering was an art. Through practice, an engineer developed intuition. For example, an experienced structural engineer just knew what size member was needed and how to optimize the structure, before performing the time-consuming manual computations. Good preliminary member sizing permitted detailed design to proceed in other disciplines while the structural engineers cranked away. But major structures designed by manual methods tended to be extremely regular. The advent of the computer informated the structural design process. Some of the earliest computer graphics for our industry were deflected shape diagrams output from structural analysis programs. Everyone could see the behavior of the structure under load. Later, color coding of stress in individual members provided even more feedback to the engineer. Now, it is a basic assumption that every structure is optimized, and ever more complex and daring forms are safely constructable.

WHERE WORK IS PERFORMED

Valentine's Day 1996 marked the fiftieth anniversary of the invention of the electronic computer. After 50 years, we have finally realized that the real power of this technology lies in its communication potential more than in its computational power. As telecommunications, computer technology and broadcast techniques converge, information technology has an increasing impact on *where* work is performed.

In the early 1990s, I frequently rented PCs to cover short-term project needs. I discovered that AT&T Capital Corporation's equipment leasing division, based at the Dallas/Fort Worth Airport, offered both better prices and better service in Chicago than any local organization did. AT&T had significantly leveraged its field sales engineers with state-of-the-art telecomputing

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