

A RESEARCH AGENDA FOR THE AEC COMMUNITY IN 2000 AND BEYOND

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Today, information technology "... is the lifeblood of the organization, shrinking the effects of time and distance and altering the very nature of work."

-- Thomas Allen et.al. Information Technology and the Corporation of the 1990s. New York: Oxford Press, 1994.

OVERVIEW OF BACKGROUND AND WORK

The principals on our research team include Robert E. Johnson, Arch.D., AIA, and Mark J. Clayton, Ph.D. and Yunsik Song. Professor Johnson has been involved in computer-aided design research and teaching since 1979, when he joined the faculty at the Architectural Research Laboratory at the University of Michigan. In 1996, he became professor of architecture and director of the CRS Center for Leadership and Management in the Design and Construction Industry at Texas A&M. Professor Clayton earned his doctorate from Stanford University at the Center for Integrated Facility Engineering. He has taught courses in computer-aided design at Cal Poly and Texas A&M. Yunsik Song is a Ph.D. student who is doing research related to information technology and facility management at the CRS Center.

Our research has involved a succession of projects including a survey of the practices of Fortune 500 facility managers (Johnson and Clayton, 1998), a series of on-site "best practice" case studies to explore how information technology was being used in selected Fortune 500 companies (Johnson, Clayton and Song, 1998) and two projects which investigated the subject of "as-built drawings" and other information practices of the facilities department of USAA, a large financial services company (Clayton, Johnson and Song, January 1998).

In summary, we found that facility managers viewed information technology as necessary and even essential in helping them to manage facilities. Facility management organizations that we visited were utilizing solutions such as paperless project management and developing integrated facility management data warehouses. At the same time, facility managers reported significant problems such as the inability to measure the results of investments in I/T, the cost of keeping operations data current in facility management systems, and the cost of acquiring operations data for facility management. We also found that each organization tended to have its own unique organizational culture and structure which frequently translated into significantly different work processes, information needs and information technology solutions.

Finally, our research on "as-built drawings" concluded that the information hand-off between the AEC team and facility managers was problematic. As one facility manager put it: "The current way of providing as-built information is not satisfactory. It may produce too much information, the wrong kind of information, or both." We came to understand that the basic problem with as-built documents is that they are designed to construct a building—not to manage a building. As we investigated further, we saw that problems of structure, format, content, accessibility and cost could not be solved without rethinking the basic purpose and organization of building information delivery and how that information related to the internal work processes of the facility management organization.

VISION #1: THE MECHANISMS FOR CHANGE

Deliver the right building information

*to the right person
at the right time
for the specific facility management task at hand*

Johnson, Clayton and Song. June 26, 1999. "Information Integration: The Downstream of Design."
Presentation at the Construction Integration Summit, CSI'99, Los Angeles.

Through our research, it became clear to us that information technology could be used to improve information access and sharing that, in turn, could substantially improve operating efficiencies. Conceptually, an approach is required that will deliver information as it is needed that is customized to the needs of a specific task, function or person. We borrowed the "just-in-time" terminology from manufacturing because we felt that warehousing inventory parts was a process that was analogous to warehousing as-built drawings and other building information documents that were need to maintain and operate buildings. Both were inherently costly and inefficient processes. We believe that this vision, which we termed "just-in-time operational documents" can help guide future research on the use of standard Internet technologies that would dynamically improve the efficiency of facility management operations. Research that might help to build on this vision might include the following topics:

Development of a prototype JIT operations manual or toolkit. The idea of a just-in-time operations manual or "toolkit" using standard Internet approaches is a vision that promises to deliver information more efficiently and therefore improve the productivity of facility managers. A "proof of concept" has been completed, and a prototype of this idea would help to better understand the strengths and limitations of this approach and would provide a means to help understand the mechanisms by which process reengineering could be implemented.

The cost of operations and maintenance data. Significant issues in any database management environment are the cost of obtaining data and the cost of keeping that data current. We found in our research that it is costly, inefficient and unnecessary to put all building information into machine-readable format. This is especially true for older buildings, for which information is often in paper format. However, we also found that facility managers do not agree about priorities for retaining and updating building information. Research is needed to better understand both the cost and the benefits for retaining and updating various types of building information. This may have implications for how best to organize and manage building information over the entire life-cycle.

Intelligent computerized maintenance management systems. The use of maintenance management systems is common in many facility management organizations. However, we anticipate that in the near future, "active" building systems will have inexpensive chips embedded in them which will communicate with facility managers when a problem has occurred or possibly predict when equipment failure will happen. "Smart" components may also allow HVAC systems to self-adjust based on the dynamic communication of changing load requirements. This research would seek to better understand the potentials for improving operating efficiencies and assess the life-cycle costs and benefits of such improvements.

VISION #2: ROLES AND ORGANIZATION REENGINEERING

"Information technology is evolving from a tool that incrementally improves "back-office" productivity to an essential component of strategic position that may alter the basic economics, organizational structure and operational practices of facility management organizations.

Johnson and Clayton. January 1997. "The Impact of Information Technology on Facility Management Practice, CRS Center Research Series.

Information technology is significantly improving the efficiency of current work processes. Internet companies such as BidCom and Blueline Online are examples of this approach, as their mission is to use

technology as a means to enable the more efficient and effective management of projects through better project communication. However, opportunities for improvement may also be found beyond revising work processes and focusing instead on a radical restructuring of the organization itself in order to take advantage of new technological opportunities. In the near future we can expect that building information will be available anyplace, anywhere and anytime. Just as products from computers to flowers can now be purchased over the Internet from virtual organizations, in the near future, AEC/FM services may be procured in significantly different ways. In response to this changing context, current business models may change in ways that are unpredictable. Potential research projects might be:

New organizational structures for the building industry. It has been argued that the fragmented and localized structure of the design and construction industry has impeded innovation and productivity improvements. With the availability of new information and communication tools, perhaps alternative organizational structures will emerge that can immediately and seamlessly share information among all partners in construction projects so that individuals are better able to perform their task despite their organizational attachment. The need for research that explores the impact of information technology on organizations has been identified for some time (see Zuboff, 1988). One recent, promising approach is to utilize coordination theory to better understand how distributed organizations might be formed to capture the advantages of information and web technologies (Malone, March 1999). Huang (1999) provides one example of this type of research in the design and construction industry. A simulation approach to this issue is the Virtual Design Team “micro theory” of project organizations (Kunz et.al., November 1998), which claims to have produced predictions that are qualitatively reasonable. Another method might be to identify each component of value (e.g., using Michael Porter’s value chain analysis) with the objective of identifying any process factors that might inhibit value to the owner.

Information standards for building design, construction and management. If the design and construction industry is to gain the benefits from the current information technology revolution, there will need to be a way to reliably exchange data among applications and possibly building equipment. Various international, government, and private organizations are developing information exchange standards for the building industry (Froese, July 1996). These standards address issues such as software interoperability, the delivery of maintenance information, and the preparation of construction documents. In some cases, however, these standards are being developed as theoretical models without the necessary empirical testing to validate them. We agree substantially with Björk (May 1999) in his discussion of methodological weaknesses inherent in much of information technology in construction research. Without rigorous testing, questionable standards may be promulgated which may decrease their adoption by industry. Research is needed to rigorously test standards against actual building data and feed the results back to standards organizations so that the result will achieve more rapid acceptance by the building industry.

The business value of information technology investments. Reasonable information technology investment decisions cannot be made unless an evaluation approach can be devised to clearly explain the probable costs and benefits for each investment. Too frequently, the value of a proposed information technology system or application to a facility management department or to a parent corporation is not evaluated because the evaluation is thought to be too difficult. Just as frequently, existing information technology operations (past investments) are not evaluated to determine their effectiveness in achieving expected goals. As a result, there is an increased possibility that resources are not being allocated in a manner that optimizes investment decisions or that inadequate information technology solutions remain in place when they should be discontinued. Research is needed to better understand how to assess the value of information technology investments in facility management.

Virtual meetings and small, virtual design teams. Research efforts have demonstrated the feasibility of network-based conferencing technology. However, the variety of competing formats has meant that a

standard has not yet emerged, and the usability of standard conferencing technology has not yet proven to be optimum for design and construction teams. While the purely audio channel of telephones is adequate for many kinds of meetings, band-width limitations still restrict the practicality of interactive digital video on the Internet. In addition to hardware constraints, the use of “standard” collaboration software for design and construction teams may also be insufficient. Further research is need to better understand the nature of the breadth of interaction styles that occur in design team collaboration so that the effectiveness of a wide variety of virtual design meetings can be assured.

SUMMARY

As the cost/performance ratio of information technology continues to shrink, information technology is almost certain to become more pervasive and raises at least the possibility of new forms of delivering design, construction and facility management services. The exploratory stage of research for information technology in design and construction is drawing to a close. The dominant need at this time is to rigorously study how these new technologies can impact industry, both in terms of best practices and consequences.

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