Impact of Downsizing of Information Technology on Engineering Operations

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Computers have helped engineers and planners improve productivity and perform tasks that are impossible for manual operation. Development in computerized information technology will certainly affect engineering operations. One of the emerging issues in the information profession is the downsizing of information technology. The scope of the downsizing is defined, the status and the pros and cons of downsizing are reviewed and evaluated, and finally, the possible impact on engineering operations is pointed out. An attempt is made to bridge the gap between the engineering and the information technology professions.

What is downsizing of information technology (IT)? In many journal articles, downsizing is defined as converting large computer systems to smaller ones. Peri (*1*) of Computer Support of North America, Inc., defines downsizing by identifying six downsizing strategies: from mainframe to personal computer (PC) local area network (LAN), from a mainframe to a UNIX host, from a mainframe to a hybrid PC LAN with UNIX hosts, from a mainframe to a hybrid PC LAN with mainframe relational data base management system, from a mainframe to a cooperative PC LAN with AS/400, and from a mainframe to a less expensive mainframe.

Some consider downsizing to go beyond just using smaller equipment. Klein (*2*), the president and founder of the Boston Systems Group, a systems development firm, defines downsizing as "a gradual transition to the dispersed usage of computer based information systems by groups of multiple individuals to support unique and specific business responsibility" (*2*,pp.2–7). He suggests that downsizing has three dimensions: equipment, systems development, and decision making. The process of downsizing will change the centralized environment to a decentralized one. It converts the large centralized equipment to distributed smaller ones, and it changes centralized systems development activity and decision making to a decentralized activity that involves users.

In this paper, downsizing is defined as having three dimensions: equipment, systems development, and decision making, as suggested by Klein (*2*). Downsizing activity will generate more benefits if it is conducted with these three components. Considering the interdependency of hardware, software, and applications, it is necessary to include factors other than equipment. There are several synonyms for the downsizing of information technology. "Client/server computing" and "distributed computing" environment are frequently used to describe the same concept with a different emphasis. The term client/server computing is used when the hardware configuration and its functionality are emphasized, in contrast to the centralized mainframe computing. The term distributed computing is used when computing power, as it relates to users, is stressed (*3*).

To predict the possible impact of downsizing of information technology on engineering operations, the purpose for and the status of downsizing should be understood.

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IMPORTANCE AND PURPOSE

Downsizing recently has become one of the most frequently discussed subjects in the information technology profession. In a survey conducted by the Society for Information Management in 1991, reported by Millers (*4*), the client/server issue topped the list of important technological advances; this indicates that more organizations are moving toward the client/server computing environment. At least three national conferences on downsizing were offered between March and September of 1992. Articles on this subject frequently appear in magazines such as *COMPUTERWORLD*, *INFORMATIONWEEK*, *PCWeek*, *CIO*, and *Business Week*. All these factors suggest that this activity deserves close attention.

Purposes for downsizing information technology vary. Peri (*1*) suggests several reasons for downsizing: cost efficiency, improved applications, avoidance of mainframe upgrading, shared data, increased reliability, and improved user and programmer productivity. Downsizing is the response of the management information systems (MIS) profession to pressures from users and management. MIS is pressed by end users to provide more services, and, on the other hand, MIS is pushed by chief executive officers to spend less. Arguments such as Peri's on cost saving for downsizing reflect the consideration of downsizing economy.

Some downsizing experts cite other factors as purposes for downsizing. Kiely states, "Ultimately, downsizing is a path to distributed computing, client/server architectures, the reengineering of outdated business process, new ways of managing information, new IS [information systems] skills, and a new job description for the CIO [chief information officer]" (*5*,p.42). Arguments such as this one consider downsizing as an effort for revitalizing an organization (*6*).

Considering its scope and purposes, a downsizing effort aims to produce the following benefits:

- Cost avoidance,
- Cost reduction,
- More flexibility in hardware configuration,

- More flexibility and efficiency in systems development,
- More computing power and functionality for users,
- Higher productivity for users and MIS professionals, and
- Revitalization of an organization's business process.

STATUS OF DOWNSIZING IN THE INDUSTRY

Technology Readiness

The readiness of the technology for downsizing is questioned by many downsizing experts who caution us to act slowly. "The technology's a little raw and new" admitted Cheryl Currid, a downsizing consultant based in Houston in a report by Kiely (*7*). Kiely reported that, in a survey to 60 CIOs and 30 vendors conducted by Input, a market research firm, the respondents, in general, believe that

> the mainframe offers better reliability and security than do PC LANs, and that there is better vendor support for mainframe. . . . In many ways, the new technology must still prove itself—especially to IS executives in large, centralized organizations. CIOs worry about coherence, compatibility, integrity, and security. (*5*,p.38)

Downsizing with current technology is not for every organization. If an organization has a high degree of homogeneity in technology and a high degree of similarity across applications, then it should pass up the technology for now (*7*,*8*). Some "considered it totally unrealistic to get rid of the mainframe when certain financial and operating information will always need to be centralized (*9*,p.56).

However, some downsizing advocates push downsizing vigorously. In the same survey conducted by Input, the respondents listed a wide array of applications they intend to downsize in 1992. "People are definitely moving in this direction" (*5*).

Reviewing the arguments from both sides, it is reasonable to conclude that the present technology for downsizing is only partially ready. For small organizations that do not require complex hardware and software configurations, the technology is available. But for large organizations with sophisticated information systems, the technology is not quite mature. The efforts required to downsize in a large scale may be greater than the benefits it can derive.

Cost Consideration

Some experts argue that cost is a major consideration for downsizing; others suggest that downsizing may not be able to save cost.

In the survey conducted by Input, the respondents cited cost saving as the driving force behind downsizing, although they doubt that downsizing will yield big cost savings. Peri (*1*) cited a survey of 25 large companies by Forrester Research that revealed that 17 of the 25 companies had replaced their mainframe entirely with smaller computers and that each had an annual savings ranging from $200,000 to $4.5 million. There are numerous success stories in saving costs. For example, Home Mutual Life Insurance Co., in Baltimore, replaced an ancient Honeywell mainframe with five PC LANs. The company will recoup its $480,000 migration costs in just 2 years. JFK Medical Center in Atlantis, Florida, substituted a RISC-based network for its mainframe, reducing IS staff costs by 25 percent and saving thousands of dollars in hardware and service costs (*5*).

But there are companies that have found the cost issue complicated and are not as optimistic as expected. Harley-Davidson, headquartered in Milwaukee, had spent about 10 to 20 percent over budget when it was only halfway through a project to move from a mainframe environment to IBM AS/400s and LANs. McKesson Water Products Company, in Los Angeles, moved some business systems from a mainframe to AS/400s, which cost the company more than it had expected to pay (*5*).

Judging from reports from both sides, it is clear that there is no guarantee of saving costs by downsizing. The cost savings depends on a variety of factors. Gartner Group predicted that the cost savings through downsizing will be realized as system tools advance over the next 5 years (*10*).

Organizational Issues Involved

What are the problems encountered in relation to the organizational issues? Is downsizing well received by all elements in an organization? In fact, some push for downsizing, but still many resist it.

In the survey conducted by the Society of Information Management, "respondents indicated that the most important issue they faced was reshaping business processes. It has become so pervasive that many believe it is the key to managing change and improving the way companies do business" (*4*,p.24). Some people, however, would rather fight than follow the trend (*6*). The resistance is caused by the fear of change and protection from losing what they have acquired. Downsizing may make some people's knowledge obsolete and eliminate jobs.

Downsizing eventually will bring an organizational culture change, particularly if it is used as a tool for organizational transformation. It will change the business process, require new skills, change job descriptions, reallocate resources, and break power balances. We should not stop downsizing out of fear of change. We should manage the downsizing to make it benefit both the organization and the workers.

Evaluations and Predictions

According to Schay, "The migration to client/server computing is inevitable" (*11*). "Client/server will be the predominant technology architecture, and it will evolve into an important application architecture" for the next decade (*12*,p.9). To predict the impact of downsizing on engineering operations, it is necessary to understand the scope of the activity and the tool and process used. The key points from the above discussion can be summarized as follows:

- Downsizing is a complex process that migrates all information systems from mainframes to smaller computers and provides distributed computing power to end users while maintaining current applications to support business needs. It needs to be well planned.

- Downsizing is a major endeavor for an organization. It will change organizational culture, reengineer business processes, and require staff retraining. It needs all-out efforts and support from top management.
- Downsizing of information technology will be continued since it can provide distributed computing power to users, be used as a tool for organizational transformation, and save costs if it is conducted correctly.
- The technology is not quite ready. For small organizations and simple applications, there have been numerous success stories. But for large organizations and complex applications, the key word is caution.
- The technology will be continuously improved; therefore, organizations should be ready to take advantage of the developments.

EFFECTS ON ENGINEERING OPERATIONS

Encompass IT Knowledge and Skills in Engineering Operation

As the computing power is distributed to the end-user's areas, users have to assume more responsibilities in using the information technology. For example, staff engineers have to know how to use hardware and software and back-up files, handle systems security, and, in some cases, use programming languages (third or fourth generation) to develop programs or simple systems for localized applications. Managing engineers have the new responsibility of managing the information resources in their areas. They have to learn how to develop staff skills to use it, how to use IT to improve productivity, and how to fully utilize the technology (*13*). These all require new IT knowledge and skills to be incorporated into the engineering profession.

Plan a "Learning Organization" to Develop Human Resources

A massive education and retraining program will be required. Information technology is a very dynamic field. New technologies and new tools appear on the market almost every month. To take advantage of these new technologies and to improve productivity we need to retrain our staff. Without the commitment to develop human resources, the result will be an inefficient work force.

The idea of a "learning organization," as suggested by Senge (*14*), should be promoted so that new IT knowledge and skills can be quickly developed. The productivity of an engineering organization in the 1990s may well depend on the rate at which its engineers relearn how to apply information technology. To increase IT skills, not only do engineering organizations need to retrain their engineers, but universities should also better prepare new engineers.

Facilitate Integration of Management and Design of Engineering Systems

As powerful computers become available on the desktop, an engineer should be able to use other new technologies, such as geographic information systems and organization-wide data bases. With these capabilities, an engineer can review the interactions in an easily understandable graphic format of multiple subjects, such as the integration of land, transportation systems, water, sewer, utility, environmental conservation, project status, and even social and economic factors. These multiple subjects have to be treated as an integral system and designed and managed with information technology. This capability, although it is not immediately available, will become a reality as an organization creates its organization-wide data base.

It is difficult now to predict the impact of this capability on the management of engineering operations. However, it certainly will affect the way engineering components are viewed in a complex urban environment. It will facilitate the integration of the management and the design of these engineering components. This move of integration will also affect engineering education.

Be Prepared Mentally and Administratively

Because downsizing will alter the information technology infrastructure and the level of service to an operation, one should assess the readiness and give an opinion on the pace of the downsizing from the perspective of the operation, regardless of one's position in the organizational hierarchy. In other words, one should neither let past practice block one's thinking nor let political considerations blur one's vision (*15*). A position is taken on the basis of business need.

On the other hand, it is necessary to assess one's readiness. Engineers should develop an action plan to guide migration for downsizing. One needs to secure financial support (*16*) for the migration, as well as automation support for the operation in transition.

Conduct Organizational Transformation

As more computing power is distributed to user areas, it will change the job nature and work load for every employee. It will make people aware of the need to review the work flow, the engineering operation processes, and the new responsibility. A review of the business process, work load distribution, organizational structure, resource allocation, and even management style is almost inevitable. As a result, an organization could become smaller, flatter, and less structured; an individual may find himself or herself either doing the same function in different ways or performing a different assignment.

Davenport and Short (*17*) use "new industrial engineering" to describe the recursive relationship of information technology and business process redesign. They suggest that

> Thinking about information technology should be in terms of how it supports new or redesigned business processes, rather than business functions or other organizational entities. And business process and process improvements should be considered in terms of the capabilities information technology can provide. (*17*,p.12)

Information technology should be viewed as more than an automating tool; it can be used to reshape the way engineering

operations are done and it should be used to improve organizational efficiency.

CONCLUSION

Downsizing of information technology can give end users more computing power, help organizations improve productivity, and revitalize business processes. Although the technology is not quite ready for large-scale downsizing, organizations should be ready to take advantage of it. Engineering organizations should realize the need to encompass IT knowledge and skills in engineering operations, to commit to a staff retraining program, to integrate the management and the design of engineering systems, to be prepared mentally and administratively, and to conduct organizational transformation by using information technology.

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