INFORMATION PROCESSING IN THE 1990's

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INTRODUCTION

Information processing technology has had a profound impact on organizations since the widespread adoption of computers in the 1950s. How will this technology influence management and organizations in the 1990s? Will there be a revolution of management theory and practice?

The purpose of this paper is to present 1) significant trends in the technology and 2) to discuss how senior management can take advantage of the technology to change the fundamental nature of a business. What does the senior manager have to do to see that information technology is employed effectively in the 1990s? What technology is most appropriate for the firm and how should it be selected? How does the firm implement new technology?

The Role of the Manager

Managers frequently complain that they are ill-prepared to cope with information processing technology. For many managers, the technology is alien and complex. Information systems professionals have often seemed to confuse issues with jargon and have brought inappropriate questions to

management. In too many firms, decisions are made based on the technology rather than the needs of the business.

Managers should insist that they make the appropriate decisions and should take an active part in the management of information processing. For a framework for managing information processing as a senior or divisional level manager, see Lucas and Turner (1982) and Lucas (1986). In the past information processing was another activity to be managed. In the 1990s information processing technology will be at the center of management planning and decision making.

The Manager as a Leader

Managers often ask, "what can I do to influence an area as mystericus as information processing? I am not an expert on the technology." There is much that the non-technical manager can and should do to lead information processing in the organization. The senior management of the firm will determine how the firm uses technology during the 1990s.

How does the general manager influence information processing activities? Mintzberg (1973) offers a compelling analysis of how a manager leads:

> "...leadership permeates all activities; its importance would be underestimated if it were judged in terms of the proportion of a manager's activities that are stricIty related to leadership. Each time a manager encourages or criticizes a subordinate he is acting in his capacity as leader...in virtually everything he does, the manager's actions are screened by subordinates searching for leadership clues."

A manager leads information processing by developing a vision for how the organization will look in the future and the role of information processing in achieving that vision. He or she leads by participating in decisions about information processing, by attending meetings and supporting the use of the technology. The manager encourages others to think creatively about technology by suggesting ways that it can be used to advantage. The manager also helps the implementation process for new technology by using information processing systems personally.

COMPETITIVE ADVANTAGE

The key question for managers is not "how can we automate this process with a computer," but instead, "what opportunities does the technology provide to gain a competitive advantage?" Leading firms are using the technology as a part of their strategy, for example, see Wiseman, 1985. Many different examples of the strategic use of technology have been cited ranging from Merrill Lynch's Cash Management Account to a McKesson system which ties drug stores more closely to this distributor.

The technology is often suited to differentiating a product or a service. A major New York bank has used the technology to offer unique cash management services to corporate customers. During the first decade of this product's life cycle, users connected to a time-sharing

system that had data on their deposits at the bank. The second generation system offers a powerful microcomputer which not only retrieves data from the bank offering the service, it also dials and retrieves data from other banks used by the customer. The services of the micro-based workstation differentiate the bank's products from those offered by competitors.

Computer technology can be used to provide a cost advantage, allowing a firm to adopt the strategy of becoming a low cost producer in the industry. The General Motors Saturn project is counting heavily on the use of computers to eliminate paper from the process of manufacturing a car. One estimate is that up to $2000 per car could be saved from the elimination of paper. Computer systems and communications networks substitute for written documents, and the technology will be applied to give GM a cost advantage over domestic and foreign producers in building an automobile.

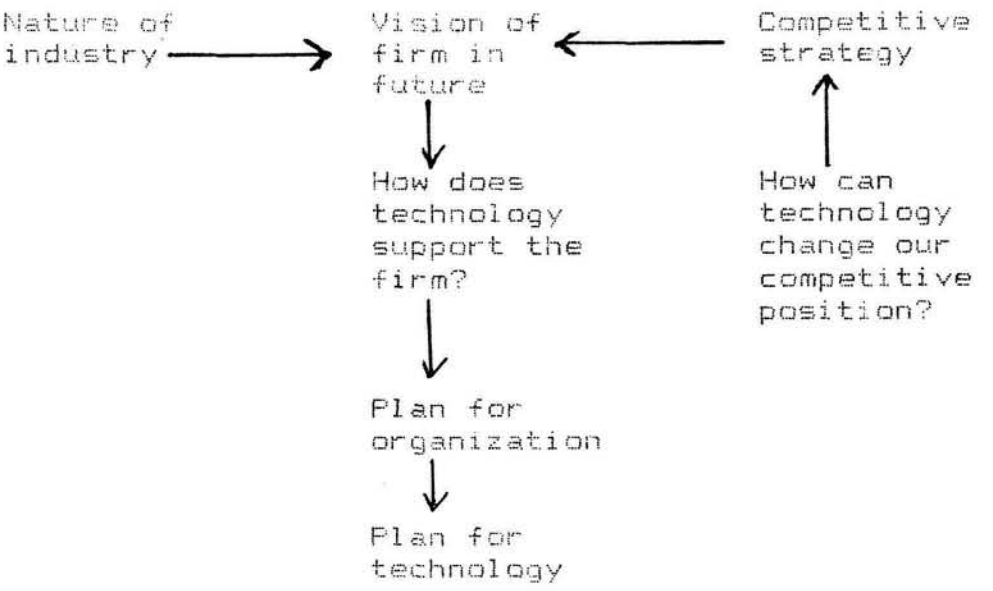
Firms have been very successful in using the technology to innovate. The Merrill Lynch Cash Management Account was the first such account offered; Merrill is estimated to have over one million customers and to earn over $60 million a year in fees generated from the money it manages via the Cash Management Account.

The Vision

A responsibility for senior management is to have a vision for the future of the enterprise. What will our

products and services be in five years? In ten years? How will the firm be organized? What will be the key competitive factors in our industry? What production technologies will we employ? What are the threats and opportunities? The fundamental thesis of this article is that the vision of the 1990s, no matter what one's line of business, will contain a significant technological component.

Figure 1 illustrates one process for developing a vision of the future. The nature of the industry and management's analysis of competition influence what the firm can and will be doing in the 1990's. Through technology forecasts, economic predictions and competitive analysis, management develops its vision. Is our strategy to become the low cost producer? If so, what does that strategy mean for our factories and distribution system?



Management's Vision of the Firm

Figure 1

Technology has two roles as shown in Figure 1. First we ask how can technology change our competitive position? How will it alter the kind of business we undertake? Reuters, long a supplier of information, expects that the technology will change its core business. From a news service, Reuters first expanded into providing financial information via an on-line computer system. Now the firm is allowing its customers to execute trades over its network so that its information providing service has become an electronic market. In the future, the Reuters will likely

generate more revenue from this electronic market than from its news and information services.

Next management must look at the support that technology is able to provide. In Figure 1 technology also supports the firm in following a chosen strategy. Online systems and communications technology are the support needed for the Reuter's system.

An important role for senior management of the firm is developing a vision of the future. Management should ask what will be the key to our success in the future? What is the role of technology in achieving this vision? GM feels that it must become a low cost producer and that technology is the way to achieve this goal. As a result it has purchased EDS and Hughes aircraft and has undertaken the Saturn project.

A Framework for Planning

The important point is that the technology not only supports the business, it makes it possible to change the way the firm competes and even to change the very nature of the firm's business.

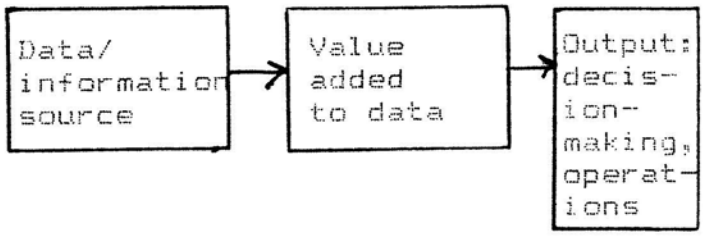
Examples of the integration of technology with corporate strategy suggest several areas in which to look such as customer service. Can we use computers to help serve our customers better? Can the technology give us an edge in becoming a low cost producer, say through CAD/CAM systems or factory-floor automation? Can a computer system

help senior management monitor the environment or the competition?

Figure 2 presents a framework to help the manager think about how technology can change the firm's approach to its business and how the technology can be used to support the manager's vision of the firm in the future. The rows of the systems map in Table 1 represent various functional areas of the firm. There are many transactions-oriented information processing systems in organizations; these applications were often the first undertaken because they were well understood and appeared to offer immediate cost savings. A typical business also has operational control systems such as those used in managing production in a factory. Managerial control is represented by financial and budgeting systems.

Applications	Originators	Processor	Users

Transactions
  Order entry
  Receivables
  Payables
Control
  Budgeting
Finance
  Cash mgt
  Treasury
Production
  Control
  Scheduling
  Planning
  Quality
Engineering
  CAD
  CAM
  Automation
Marketing
  Customer
   service
Planning
Strategy
Competition
Environment
  Scanning



The Systems Map

Figure 2

The columns in Figure 2 represent three groups involved in a typical information system: originators, processors and users. Originators develop and distribute information while a processor adds value to data in some way. Users are interested in processed data for making decisions and running operations.

The systems map helps identify possibilities for using the technology in a strategic manner by shifting from one category to another. For example, can a firm process some of the information it originates for others? Alternatively, can we process information developed by customers, e.g. by connecting customers to our online order entry system?

Consider Reuters which at first was only a distributor. Its customers were the processors and the users of data; they made decisions and executed trades based partially on information provided by Reuters. Now Reuters is becoming the processor for customers by allowing users of its information to make trades over the Reuters network. See Table 1.

	Original	With Trading
(Type of system)	Transactions	Transaction-strategic
Originator	Reuters financial data	Reuters network data & trading
Processor	Customer through external trader	Trading service provided by Reuters
Users	Customer	Customer & customer's customer

Reuter's System Map

Table 1

In another example, American Hospital Supply corporation, now a part of Baxter Laboratories, provided its customer hospitals with terminals connected to the AHS order entry system. Customers use the terminals to enter orders for the products provided by AHS. AHS also sold its customers software to manage hospital inventories and perform other tasks, thus tying the hospitals more closely to AHS.

Prior to the system, the customer originated information in the form of orders. The orders were sent to AHS which processed them. AHS was the primary user of the information to determine what to ship to the hospitals. By placing terminals in hospital offices, AHS made its customers the processors as well as originators of information. The system reduced AHS order entry costs, improved customer service by reducing the time from ordering to receipt of merchandise, and tied customers more closely to AHS.

Table 2 applies the systems map to the cash management workstation discussed earlier. The system did not change the originator of service; it remains with the banks who hold customer deposits. However, the workstation has become a new processor; it collects data from all of the originators of data and presents it to the ultimate user.

The bank which developed of the workstation is now identified as the provider of a customer's major cash management processor.

	Without micro	With micro
(Type of system)	Tansactions managerial control	Transactions managerial control competitive
Originator	Many different banks	Many different banks
Processor	Bank customer	Developer's system processes for all customer's banks Developer=cash management provider
Users	Bank customers	Custommer of many banks

Bank Micro Cash Manager System Map

Table 2

The framework in Figure 2 may be helpful in thinking about some of the opportunities provided by information processing technology. It is important for management to have a vision of the firm and to think about the role of technology in this vision. Then, as suggested in Figure 1, the manager must develop a plan to achieve his or her vision for the firm and a plan for the technology. The following sections are an assessment of the technology that is likely to be in widespread use in the 1990s to assist in this process.

A SCENARIO

Developing a vision for the future is not an easy task; there is very little that one can do to learn creativity. A scenario is a useful approach to generating ideas for planning. In this section, we shall follow the manager of a division of a manufacturing firm sometime in the early 1990s.

Our manager, Bob Howard, has just returned home after a three-day business trip. He enters his study which contains a microcomputer. From the menu that appears when Bob turns on the computer, he selects the "read mail" application and is automatically connected to a corporate computer that acts as the main message switch for the firm's electronic mail system.

Bob reviews his mail messages, reading some and placing others in files for later followup. He replies to about half of the messages, sometimes including copies to others as a part of his reply. Bob then consults the notes he made on the airplane, and composes two memos to his staff members. He addresses each memo to a name which refers to a list of recipients so that multiple individuals receive each message.

Included in Bob's mail are three messages from remote locations, two from a customer and one from a supplier. Bob responds to two of these messages, and puts an electronic reminder on the system to call the customer who sent the third message to discuss a delicate issue on the telephone.

Though tired at this point, Bob has been away from the news for several days so he calls up summaries of important domestic and international news on the terminal. After reviewing the news, Bob runs the expense account program to record his expenses. The system prompts for the expenses and performs all of the calculations. The next day accounting will review and authorize the expenditures and initiate an electronic transfer of funds to Bob's personal checking account for the money the firm owes him on the trip.

The next day in the office, Bob works with a microcomputer that is similar to the one in his study at home. The office machine, however, also has a voice recognition capability so that he can speak the commands

instead of type them. Being a reasonable typist, Bob does not use this feature. However, for preparing letters and memoranda, he does dictate slowly to the computer which converts his spoken words into written text. A secretary reviews the written text and makes any corrections needed.

Bob walks to the office of his assistant to discuss the presentation he must make at headquarters. His assistant shows him the rough drafts of the exhibits she is making for the meeting. Bob will use a large screen display to project the exhibits on a screen at the conference room at headquarters. His assistant promises to have all of the displays finished that afternoon and will transmit them to Bob so that he can review them from his workstation at home that night.

This scenario offers just a few examples of how a manager will be affected by the technology in the coming years. All of the applications envisioned above except for the speech dictation system exist today. Why is the scenario something for the future? There are few organizations which have integrated all of these applications to form a single managerial workstation and to combine the workstation with a communications network. Also, many managers are not convinced that a computer can help them in their own work, having been discouraged by their firm's unsuccessful information systems on large, mainframe computers.

Note also that this scenario is incomplete because it does not address the use of the technology for the basic processing of the firm or for competitive advantage. Such scenarios can and should be developed, but they are dependent on the specific organization involved. In summary, this scenario is intended to demonstrate some of the ways in which an individual manager can expect to utilize the technology and to illustrate how scenarios can contribute to the planning process.

TECHNOLOGICAL TRENDS

Techology is advancing at a blistering pace. However, since the 1990s are fast approaching, much of what will be available in the next decade is in the laboratories now. While predictions are always risky, a technology assessment is important to the firm in planning for the future. This section presents signficant trends in the technology which should help the firm in determining how to use information processing to gain a competitive advantage.

Cheaper, Novel Processors

The trend toward less expensive, more powerful processors should continue. Vendors are already shipping 32 bit microprocessors in the next generation of workstations. The most popular microprocessors today fetch 8 bits at a time from memory and perform calculations on 16 bits at a time (and hence are called 16 bit processors.)

It is unlikely that there will be a need to go beyond 32 bit processors, at least for microcomputers. Beyond these 32 bit chips further improvements in cost and performance will have to come from refinements in the chips themselves and from lower production costs. Several vendors have introduced computers which employ reduced instruction sets; only the most frequently used instructions are "wired into" the chip. Reduced instruction set computers (RISC) may offer a speed advantage since they contain a smaller number of instructions which can execute more quickly than conventional processors.

Another alternative for obtaining more processing power is the use of more novel computer architectures. There are a number of experiments underway now to determine if alternatives to the conventional von Neumann architecture offer advantages. Most of the alternative approaches are designed for higher speed computers than micros. The most promising ideas at the present time are for computers which use a large number of processors working in parallel to solve problems. The drawback to this approach is the problem of coordinating the processors and breaking the problem on the computer into parts which can be worked on in parallel. For further discussions of computer architectures, see IEEE Spectrum, January 1986.

Workstations

The workstation described in the scenario will become an increasingly common sight in offices. The workstation

will be built around a microprocessor of 16 or 32 bits; it will feature a high-resolution color graphics display, a large hard disk with 20 to 50 million bytes of storage, a draft printer and a modem for communicating with other computers. There will also be specialized peripheral devices depending on the way in which the workstation is being used, for example, optical disk readers for access to large amounts of data (see below).

Because it appears that workstations can dramatically improve managerial productivity and the quality of work, organizations in the 1990s will create an environment in which there is likely to be more than one workstation per professional employee. Key executives, as in the scenario above, will have workstations at home as well as at the office.

Special applications of workstations will extend beyond engineering and management. There are now a number of in-house publishing systems based on micros. These systems can produce professional quality publications, cutting development time and cost considerably.

Communications Networks

The proliferation of microcomputer-based workstations, the increasing trend to connect organizations with suppliers and customers, and the growing popularity of electronic communications all provide impetus for a growth in communications networks.

At the present time with the deregulation of AT&T, it is difficult to forecast the environment for networking in the 1990s. It is likely that there will be a variety of services available for wide area networks which connect locations separated by from a few miles to thousands of miles. The common carriers will offer switched services for digital transmission and packet networks like Telenet will continue to be popular.

Some firms will want to control their own communications and bypass phone companies. Private networks to accomplish these purposes such as the one developed by Citibank, are very expensive and are likely to be developed only by the largest firms.

The use of local area networks which tie together computers and other devices on one or two floors of a building should expand rapidly. By the 1990s there should be two or three standard networks, each of which will support most vendors' products. Local Area Nets (LANs) are constrained now by the high cost of connecting each computer to the network and by confusion over standards for the networks. Costs should drop making it economical to connect computers to local networks and two or three approaches like Ethernet and the IBM token passing scheme should become standards.

For factory automation, the GM initiated Manufacturing Automation Protocol (MAP) will greatly facilitate the development of flexible manufacturing. Today system

integrators package equipment from a large number of vendors to build computer integrated manufacturing equipment. The adoption of MAP will ease communications among devices from different vendors, simplifying the development of automated factories.

Fourth Generation Languagges

A Fourth Generation Language (4GL) is a language that is at a much higher level than COBOL or FORTRAN. These languages feature statements like SELECT EMPLOYEE WHERE SALARY GT 30000 AND YEARS GT 10. This statement might retrieve all employees who have a salary of over $30,000 per year and have worked more than 10 years in the firm. In COBOL, it would take many statements to accomplish this processing task, especially for printing a report with the results.

A Fourth Generation Language makes it possible to reduce programming time since the level of detail of a language like COBOL is not required. These languages have been become popular with users who write their own programs rather than wait for a computer professional to become available. The languages have made possible the phenomenon of end-user computing. As long as the information desired exists on the computer and is not spread across too many different files, a user can retrieve and manipulate the data he or she wants relatively easily with one of these languages.

We also expect to see firms using 4GLs for their production programming in place of COBOL. One experiment has shown that there is great potential for increasing programmer productivity with these languages, but that there may be a cost in execution time (Harel and McLean, 1985). Since programming and systems development is such a bottleneck, firms will make the decision to purchase more powerful hardware if required to obtain greater programmer productivity through the use of 4GLs.

Systems Development

In the past five years, packaged software has become a significant force in information processing. The costs and time plus the frequent inability to produce a good system, have made a custom-developed application much less appealing today.

The quality of applications packages has increased as new generations of software have been released. Many packages have been around for over ten years, and have experienced constant improvements during this period. Also the mass market for microcomputer software has forced vendors to develop software packages that are easy and appealing to use. Packages will continue to grow in popularity: the first question will be "can we find a package?" for a new application rather than "how much will a custom system cost and how long will it take?"

Workstations will be developed to assist analysts and programmers when it is necessary to develop a custom system.

The jobs of the programmer and systems analyst will continue to merge. The final objective will be to have automatic programming packages so that the systems analyst can generate programs after entering a description of the system's requirements in to a workstation. Such systems should reduce the need for programmers and change their role to one of developing software for packages and specialized uses. The work of the programmer will be leveraged; instead of developing a custom system, he or she will develop systems capable of producing custom applications.

I/O Advances

Providing input and producing output continues to be a bottleneck for computer systems. An increase in systems that link organizations together like the one developed by American Hospital Supply will reduce the amount of data reentry, but input will continue to require a significant amount of human effort.

For factory applications, there will be extensive use of bar codes which allow the movement of parts and materials to be tracked with little or no keying of input. For office work, there will be increased use of electronic transmission of documents rather than paper copies. A copy on paper will be printed for review or for making notes, but most documents will be exchanged by electronics. When it is necessary to work from a paper copy, Optical Character Recognition (OCR) readers will handle input.

Many systems will feature natural language or restricted natural language inquiry. The user will not have to remember command syntax to ask a question of a database. Other interfaces will provide the ability for the user to make an inquiry by giving an example. The objective here is to make it easier for a user to interact with data.

The biggest potential and greatest unknown at this time is with voice recognition technology. Current systems are very limited in what they can recognize, see Personal Computing, April 1985. However, there are promising developments which may produce a breakthrough in understanding speech (Time, April 1, 1985). It is likely that in the 1990s a significant number of nontypists will communicate with computers using brief, spoken commands. It is also likely that these individuals will be able to dictate short letters and memoranda into a machine which will convert the words to written text. However, for individuals accustomed to working with a keyboard, the keying of commands will probably be faster and more natural than the available speech recognition systems.

Optical Storage

Optical disks offer the potential for vast amounts of storage at a relatively low cost. One of today's optical disks can store 200 million bytes of data or enough characters for about 1000 books. It is now possible to buy a database on the 10,000 publicly traded firms in the U.S. which contains historical financial statements, excerpts

from SEC documents, the text of security analyst reports and abstracts of magazine articles about the firms. The database comes with an optical disk reader that is used with a microcomputer. The low cost of mass producing data for distribution on optical disks suggests that much information which could be sent over communications lines will be distributed in physical form via a disk.

Today's optical disks are read-only; one can at most write data once. Optical disks that can be erased are now in the laboratory and should be available by the 1990s. This technology will probably eliminate or drastically reduce the use of magnetic tapes and will eventually replace magnetic disks, though probably not until after the year 2000. Optical disks offer a firm many exciting possibilities for the storage and distribution of vast amounts of data.

Data Base Management Systems

Data Base Management Systems (DBMS) have been available for over 15 years, at least for mainframe computers. There still are a large number of organizations which have not adopted this technology, however, their numbers are steadily decreasing. For multiuser applications on mainframe and minicomputers, there the 1990s should bring a database environment to most organizations. This environment will be characterized by a database management system (probably relational), a highly integrated data dictionary, and a query language or Fourth Generation Language for programming.

On the microcomputer scene, personal filing and storage systems will become the third most popular use of a personal computer after spreadsheets and word processing. Current DBMS software on micros is beginning to approach the ease of use of spreadsheets; by 1990 this kind of program will be common on managerial workstations.

Artificial Intelligence

AI is being applied to business applications primarily in the form of expert systems. These systems capture the rules used by human experts and place them in a knowledge base. Expert systems are in use for configuring DEC VAX computers and two firms offer expert systems for providing financial advice, one of which contains 6000 rules. More expert systems will be developed to give a firm an edge on its competition.

Office Automation

Office automation is an amalgamation of a number of tools including electronic mail, word processing, and personal services like electronic calendars. Office automation and communications will be integrated under information services and will report to the chief information officer. Electronic mail will become more prevalent and will be used to entice managers into hands-on use of computers. Voice mail systems will also be used since they do not require the availability of a terminal and are an advantage where travel is involved. Office

automation will be a feature of vast computer networks connecting many of a firm's processors together.

Pattern of Processing

Several of the trends predicted above suggest an evolving pattern of processing in the organization. First, the economics of hardware versus labor to produce software favor continued substitution of hardware for systems development and programming time. Orgnizations will be forced to adopt analyst/programmer workstations and Fourth Generation Languages if they are to complete a fraction of the applications demanded by users.

This high demand for and low supply of systems development resources will lead to a dramatic increase in the amount of computing done by end users working with micros and Fourth Generation Languages. As users undertake more computing and become accustomed to functioning with a workstation, office automation and traditional forms of information processing will merge (Benjamin, 1982). The workstation will perform local processing, make inquiries of a mainframe computer's database and will also handle office automation tasks. Capabilities such as those described above require firms to build networks of computers which are able to communicate with each other.

At first, we will see more distributed processing as users continue to acquire micros and departmental minicomputers. However, as the burden of supporting equipment continues to rise, there will be a trend toward

asking a centralized information processing group to take more responsibility for operations, support and service. Users will find that they do not want to run their own computer centers.

As software and hardware becomes easier to use and there is more networking, the actual location of data and processing power should become less important. Certainly there will be distributed processing in the microcomputer-based workstation. However, for access to data and programs and specialized computing demands, the user should not be concerned with whether the computer is next door or thousands of miles away. Of course, this theory only works if a professional computer staff is able to successfully operate a complex of computers and communications networks.

Summary and Implications

The trends above have a number of implications for management and the organization. First, information processing involving computers and communications networks will become even more integral to the functioning of the firm. The firms that succeed in the 1990s will be those able to manage information processing technology and use it to gain a competitive advantage.

Management can also expect to spend an increasing amount of money on information processing. Traditional, operational systems will continue to expand in scope and will handle larger numbers of transactions. At first, a few banks had automated tellers connected to their central

computers; now banks are joining in regional and nation-wide networks of automated tellers to increase the level of service they provide to customers. Costs and the banks' dependence on the technology also increases.

There is no one right amount to spend on information technology. Firms will cost justify some systems and will undertake other applications because management feels the firm may gain a competitive advantage by doing so. Firms will move toward the use of steering committees for making decisions on new proposals for the use of the technology (Nolan, 1982) in order to obtain widespread input and judgment. Cost savings will be used less to justify these investments in technology.

Finally, managers and others will be more involved in information processing technology than ever before. Managers will use the technology for personal support, look for ways to gain a competitive edge with the technology, and spend a considerable amount of time actually managing the information processing effort, itself.

THE IMPACT ON THE ORGANIZATION

What do these trends and their implications mean for the organization? First, information processing will be used in a wide variety of ways in the firm. Second, these uses of technology can change the nature of the firm and its industry. Finally, there will be an impact from the use of the technology on the structure of the firm and on its

employees. In this section we discuss each of these aspects of information processing in turn.

Applications of the Technology

What can the organization do differently than it does now by using the technology of the 1990s?

1. As discussed earlier, the firm can use technology to gain a competitive advantage; the technology becomes a part of the firms strategic thrust. See Lucas and Turner, 1982; Ives and Learmonth, 1984; Parsons, 1983; McFarlan, 1984.

2. The technology will be used to create interorganizational systems, systems that tie together two or more organizations. Bank automated teller networks and the American Hospital Supply order entry system are examples of systems which span organizational boundaries. This type of system reduces labor and ties firms more closely together.

3. Organizations will move rapidly toward paperless factories. Tandem Computers already operates a facility that is close to paperless. One of the objectives of GM's Saturn project is to eliminate paper from the process of ordering, building and delivering a car. In fact, Detroit is already forging electronic links with some of its suppliers (Business Week, August 26, 1985).

4. The technology will be used to redesign and restructure the organization, especially electronic mail and communications systems. A few firms have used information systems and electronic mail to reduced the number of layers

of management and others are expected to follow (Business Week, October 8, 1984). In addition to the possible reduction in the layers of management, communications technologies present the opportunities to develop new organizational structures.

Many firms are organized into departments containing individuals who need to communicate with each other. What if there are enough communications options that individuals do not have to be grouped together physically to communicate? Would it make more sense to have an engineer in the factory where there are production problems communicating with his or her colleagues electronically rather than in an office in the administration building? See Olson and Lucas, 1982.

5. Computers will be applied to the basic production processes of the firm. Factories will continue to adopt automation and there will be an emphasis on connecting systems for factory automation with existing information processing computers in the firm. The technology will also be used to offer new services and products.

6. Computer Aided Design and Computer Aided Manufacturing (CAD/CAM) will experience continued growth. CAD systems will be linked with CAM so that eventually there will be a closed loop from design to production.

7. Electronic mail will pervade the office and there will be many external mail systems in which members of different organizations communicate electronically.

8. Firms will develop more Expert Systems, systems which record the expertise of an individual as a series of rules. For example, automobile manufacturers are interested in this technology as a way to make diagnostic and repair expertise available at all dealers' service departments.

Impact on the Industry

Information technology may change the nature of the firm and the industry. We have already seen the example of Reuters which is undergoing a transformation from a supplier of information to a processor. See Business Week, June 17, 1985.

The use of computer systems has raised barriers to entry in a number of instances. American Hospital Supply's systems are given partial credit for forcing at least one rival to drop national distribution and concentrate on being a regional firm.

Small airlines are prctesting the barrier to entry that a major carrier's reservations system raises. A carrier that cannot afford its own system must rely on the trunk carriers who have captured the market with travel agents. If the small airline is not given neutral or favored treatment, its flights may never appear on the reservations screens!

Industries may find the economics of production changed by the technology. Printing and newspaper production have been dramatically affected by computer technology. Linotype machines have been replaced by computers with far more

capabilities for editing and formatting stories. Systems exist today for newspaper page layout and newspapers will probably be forced to adopt these systems to control the costs of production.

Impact on Employees

There is relatively little documentation of the impact of the technology on individual employees. As discussed above, jobs have been eliminated at individual firms, yet the U.S. economy has created millions of jobs during a period in which the number of jobs in Europe remained constant or declined.

Looking at the trends in applications and the technology, we can speculate on their likely impact on what employees do at work. First, we expect clerical jobs will become less tedious and more demanding. Clerical employees will have to be more highly trained and are likely to encounter more stringent hiring requirements. There is likely to be a reduction in the need for clericals.

Secretarial positions may be reduced in number as well. We expect the nature of the secretarial job to change; professionals will take over some tasks previously done by secretaries. Voice input for dictation will eliminate the use of shorthand or dictating equipment, freeing the secretary from transcription chores. The secretary, however, will have to correct and revise the results of voice input. Professionals will enter more of their own

first drafts and will communicate more electronically with secretaries.

Middle management has proven remarkably resilient as changes have occured in organizations. Middle managers are likely to adopt the technology and become leaders in its implementation. The same will be true of the staff; the tools furnished by a workstation are of immediate, direct benefit to this group.

The demands on senior management will be severe. These managers will have the responsibility to develop creative applications and to seek a competitive advantage through technology. They will have to lead and manage information processing in the firm and are likely to be expected to use workstations, themselves.

There also will be new positions created by the technology. Of course, there will be a need for communications specialists and data base administrators. However, these positions are within information processing. We also will see managers of end-user computing who work in functional departments of the firm, assisting users in doing their own information processing.

There will also be a need for a technological strategist, an individual who monitors the environment and the technology and advises management on how to take advantage of new developments. See Lucas and Turner, 1982. As firms develop more links with suppliers and customers, there will be a need for a "vice-president of external

relations" to deal with the technological and business relationships involved. Systems which connect to customers are extremely important; they must be managed and work well. The developing organization will need someone who can deal with technical problems, but who also appreciates the importance of the business relationship with the customer.

BARRIERS TO SUCCESS

There are a number of potential barriers to the successful utilization of the technology of the 1990s. These barriers fall into three major categories: organizational, technical and managerial.

Organizational

How much change can an organization absorb at one time? General Motors bought an external company, EDS, to handle the computing requirements of Saturn. It also established Saturn as a separate entity and has negotiated new labor contracts for the plant. The integration of EDS into GM has not been smooth, yet GM felt it was necessary to create an entirely new entity in order to employ technology to produce the cost savings necessary to restore its competitive edge. Most firms will not have the luxury of starting a new division; will they be able to absorb and carry out the changes needed to achieve management's vision?

Do organizations have the implementation skills to apply the technology? See Olson and Turner, 1985, and Lucas, 1975. Much of the technology that will be available

in the 1990s is here today; the real issues are integrating and implementing it in organizations. Implementation is an organizational and behavioral phenomenon; often it is left to technologists who do not understand its consequences. Management has an important role in seeing that the orgnization is prepared to implement the technology and in guiding the implementation effort.

Employee resistance may also be a factor. Some workers have realized that the firm must remain competitive to survive, but that does not mean individuals will necessarily adapt to the technology and cooperate with its implementation. Many managers are resistant to technology, partially because of the failure of many past systems, but also because of fears of the unknown. Finally there is a tremendous education task ahead as employees learn how to work with new technology.

Technical

One of the major barriers to achieving technological goals in a firm is the applications bottleneck; there are many more applications needed than the typical firm has staff to develop. End-user computing is a partial solution to this problem as it can reduce the number of maintenance and enhancement requests for existing systems. The more end-users do themselves, the less demand they place on the computer professional in theory. The only problem with this reasoning is that end-users may exceed the capabilities of

what they can accomplish with existing applications and databases and ask for more work from the systems group. Workstations and new approaches to generating applications are also a partial solution to this problem; hopefully by the 1990s we shall see hardware and software systems that provide a major increase in programmer and analyst productivity.

New applications also have to be maintained which adds to the growing burden of systems maintenance. On the average it is estimated that 50% of discretionary programmer/analyst time is devoted to maintenance.

A growing technical problem is the proliferation of alternatives for hardware, software and communications. The choice of applications and the appropriate technology for developing them is far more complex today than it was a decade ago. This trend will continue, making it very difficult to develop a systems architecture and adhere to it.

Since we expect to see more interorganizational systems, firms will have to interface their computers. The cash management system we described earlier based on a microcomputer has to have data on the format for over 100 banks that it is capable of dialing to obtain a user's balances. There are no standards among the bank computer systems that allow a customer to inquire on balances; the microcomputer has to provide the standardization. Other

interorganizational systems will face some of the same problems.

A final technical problem is the interface systems present to users. There is no accepted standard of design; just as there is no one configuration for the controls of an automobile that all manufacturers accept. Someone working with four different applications is likely to find four radically different approaches to input. This situation complicates installation and training and discourages the development of workstations which serve multiple functions.

Managerial

The most serious impediment to realizing the potential of the technology of the 1990s is management inattention and apathy. Many managers maintain a careful distance from information technology and from decisions about its use. Possibly this behavior is motivated from past disappointment or a lack of confidence in the manager's ability to control the technology.

Management inattention inevitably reflects itself in the quality of Another information processing in the firm and in a lack of planning for technology. Earlier in the paper we described Mintzberg's observations on how others in the firm take their cues from management; if senior officers do not provide technological leadership, there is little hope that the firm will be able to obtain the full potential of the technology of the 1990s.

Leadership means encouraging (and sometimes requiring) others in the firm to become involved in planning and implementing information processing systems. It means that the firm will have to invest in information processing, not only for positive reasons, but to avoid faling behind its competitors. Good examples of organizations that have failed to keep pace with the technology and are suffering for it include the U.S. air traffic control system, the Social Security Administration and Bank of America.

In order to be successful, senior management will have to learn about the technology, probably use technology personally, and will have to devote significant amounts of time to the management and control of information processing.

IMPLICATIONS FOR ACTION

Earlier in this paper, we introduced the idea that senior management needs to develop its vision of the future and to convert that into a plan for the organization. Below are steps to take advantage of coming technology:

1. Review the nature of your industry and forecast the strategy of competitors.

    a. Appoint a "technological strategist."

    b. Conduct an assessment of coming technology.

    c. Ask how the technology can change the way your industry operates.

    d. Determine if the technology offers a chance

to enhance the firm's competitive position.

2. Develop several scenarios of how the firm might look in 3, 5 and 10 years.

3. Choose a scenario as the "vision," a planning objective.

4. Determine the technology required to support the desired scenario.

5. Ask where we are now? What steps are required to achieve the vision for the future?

6. Develop an implementation plan and determine the resources required to achieve it. What are the risks? Develop a program to reduce the risks through education, a new reward structure, etc.

7. See that managers learn enough about the technology to make decisions and manage its implementation.

   a. Become a user of the technology and lead the firm by example.

   b. The least painful way to begin is with electronic mail; use a microcomputer as a "dumb" terminal for mail.

   c. Gradually explore the power of spreadsheets and word processing; ask the micro experts in the firm to recommend programs to help in your own personal productivity, programs that match your managerial duties and style.

8. Manage the implementation of the plan.

   a. Provide resources.

b. Remain interested in implementation; monitor progress on the plan.

c. Maintain a visible presence when key technical issues are being considered.

9. Continually search the environment for new opportunities.

a. What does new technology offer?

b. What are our competitors' strategies?

c. What are other firms and industries doing that may be a model for us?

10. Look for ways to use technology to provide flexibility in how you are organized and how you operate.

a. Seek new production technologies, new services and products, and new ways to deliver services and products.

b. Consider how electronic communications can make new organization structures feasible.

The most important action is to develop a vision of the firm for the future and to continually think about how information processing technology impacts that vision.

CONCLUSION

We can see today much of the technology that will be available in the 1990s. The likely impact of this technology can a be predicted based on what is happening in leading edge organizations today. Technology, however, is too important to be left to the technologists. Managers

will determine the success firms enjoy in the 1990s and how the technology will contribute to that success. Technology enables the firm to move in certain directions and it supports the firm's operations. Now is the time for management to develop its vision of the firm in the 1990s and to make current decisions with that vision firmly in mind.

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