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MANAGEMENT INFORMATION SYSTEMS

After studying this chapter, you should be able to:

- A Discuss why information is important to organizations.
- A Identify important characteristics of information.
- A Describe a management information system, including characteristics, components, and design. A Identify keys to the success of management information system implementation and use.
- A Explain the nature and uses of decision support systems. A Recognize when decision insight systems may be useful and tell how they are used.
- A Describe how an expert system works. A Discuss the impact of management information systems and related management decision aids on organizations and society.

The following vignettes suggest some of the ways managers are acquiring and using information to increase their efficiency and effectiveness:

Xerox Corp. is reaping the rewards of faster shipments of almost 20 percent of the manufacturing costs in its copier division. It now exchanges quality-control information with its suppliers via computer terminals to eliminate the expensive inspection of incoming parts. In turn, the copier maker gives suppliers its master manufacturing schedule so they can ship parts at precisely the time Xerox needs them in its production line, thus keeping inventories lean.¹ Many managers through their microcomputers can now access up to 2,400 on-line databases. The full texts of stories and articles from hundreds of journals, newspapers, and trade publications can be called up instantly. Information on credit markets and currency quotes, industry developments, pending legislation, ski conditions, and Japanese baseball scores are a few keystrokes away.²

When AMP Inc. ran a sales contest in the fall of 1980, executives of the \$1.2 billion maker of electrical connectors were

1. *Business Week* (August 22, 1983), 98.

2. D. Seligman, "Life Will Be Different When We're All On-Line" *Fortune* (March 4, 1985), 68-72.

chagrined to discover they could not declare a winner. The reason: They didn't have the necessary information. Although the Harrisburg (PA) headquarters regularly received sales reports, it did not have the breakdown by product line it needed to find the best salesperson. Now, AMP has an information center. Among other things, the center allows managers to determine how fast each of AMP's product lines is moving and how fast the divisions are writing off inventories that are not selling. As a result of such analyses, AMP restructured its inventory and was able to increase domestic sales by 25 percent while shrinking inventories by 2.5 percent.³

It has been estimated that the daily output of U.S. offices includes 600 million pages of computer printout, 234 million photocopies and 76 million letters.⁴ And these figures don't even include managers' phone calls, meetings, or day-to-day observations. Such tremendous amounts of paperwork and other data are frustrating to many managers and may hurt their productivity.

In this chapter, we will see what can be done to better manage and use information. We will first consider information and information management. Next, we will consider the uses, components, design, and implementation of management information systems. We will then examine three new developments—called decision support systems, decision insight systems, and expert systems—which are closely related to management information systems. Together, these systems promise to improve the ways managers acquire, integrate, process, and use information. Finally, we will consider the impact of management information systems and related management decision aids on individuals, organizations, and society.

INFORMATION AND MANAGEMENT

Information is the lifeblood of organizations. Flows of information allow the organization to function, to coordinate its parts, and to respond to new challenges. Clearly, managing information is an important and difficult task.⁵

3. *Business Week* (September 13, 1982), 118, 123,

4. *Data Management* (November 1981), 43.

5. For detailed discussions of information and information management, see J. G. Burch, Jr., F. R. Stratcr, and G. Grudnitski, *Information Systems: Theory and Practice*, 3d ed. (New York: John Wiley & Sons, 1983); B. R. Ricks and K. F. Gow, *Information Resource Management* (Cincinnati: South-Western Publishing Co., 1984); and J. F. Magec, "What Information Technology Has in Store for Managers," *Shan Management Review* (Winter 1985), 45-49.

Information Defined

The dictionary defines **information** as knowledge communicated or received concerning a particular fact or circumstance. Information, therefore, is not just facts and figures and charts and maps. Rather, it is knowledge that is passed along to enlighten or to inform.

Many, if not most, of the figures, calls, and other data that managers receive are not really information. Rather than informing, they overwhelm. Still, the problem is not just one of cutting down on paperwork, phone calls, and the like. Much of the information managers need simply does not reach them, or it is in the wrong form, or it comes too early or too late.

How Managers Get Information

Henry Mintzberg [1975] studied managers as they went about their day-to-day work. What he saw was a bit surprising. Rather than finding long-range planners who would block out days to analyze important issues, Mintzberg saw managers performing a wide variety of brief, often unrelated tasks. Instead of getting all information from a single all-knowing computer terminal, the managers used five different media—documents, telephone calls, scheduled meetings, unscheduled meetings, and observational tours. Of these, managers strongly favored telephone calls and meetings. The manager's job emerged as hectic, overloaded, and fragmented. And, Mintzberg concluded, things will only get worse.

Information Resource Management

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Information Resource Management is the name given to a new field that has developed in recognition of the fact that information is a valuable resource in need of systematic management. Our society has seen tremendous growth in the area of information services in this century. While in 1890, 46 percent of the population was involved in agriculture and 4 percent in information services, that figure had reversed by 1979. Only 4 percent of the population was in agriculture and 46 percent was in the information business.⁶ Despite this growth in the personnel devoted to information services, only in very recent years has attention been given to the need to recognize information as a valuable resource.

In fact, information has all the characteristics of a resource. Information is clearly a valuable asset to the firm. And, it costs money to collect, store, transmit, and display information. Like other resources, information has qualities: It may vary in timeliness, accuracy, and format.

6. M. U. Porat, "The Information Economy" unpublished thesis (Stanford University). As reported in *The Wall Street Journal* (February 23, 1981), 1.

Furthermore—and this is of prime importance for management purposes—the amount or degree of these qualities can be altered. Information handling systems can be designed to deliver information sooner or later, of higher or lower quality, in the form of text, numbers, or images. Many firms are now using their information as a valuable strategic weapon. For instance, financial service companies are spending millions of dollars to create information management systems that are faster and more flexible than those of their competitors. Fidelity Brokerage Services Inc. spent \$8 million for a proprietary system that has vaulted it to the No. 2 slot in the discount brokerage business. Its system allows a broker using a ctesJ<-top terminal to execute stock trades more quickly and less expensively than most competitors who buy their services from outside computing companies.⁷

information, if handled properly, can be a valuable strategic weapon in the battle against competition.



Information Value

A number of things determine the value of information to a manager. For instance, Roman Andrus has suggested four sorts of utility of information :⁸

A Form utility. As the form of information more closely matches the requirements of the decision maker, its value increases. Information which uses an unfamiliar format or jargon will probably be ignored.

A Time utility. Information has greater value to the decision maker if it is available when needed. For this reason, some data

7. *Business Week* [August 22, 1983], 98.

8. R. A. Andrus, "Approaches to Information Evaluation," *MSU Business Topics* (Summer 1971), 42-43.

processing equipment has been designed to provide instantaneous (real time) delivery and display. While real time information is generally not needed, missing or tardy information can cause costly errors or delays.

▲ *Place utility (physical accessibility)*. Information has greater value if it can be accessed or delivered easily. On-line systems, with which managers immediately access needed information, maximize both time and place utility.

A *Possession utility (organizational location)*. Internal structure and external effectiveness are functions of the location of information within the firm. The possessor of information strongly affects its value by controlling its dissemination to others.

This discussion suggests that information appropriateness, availability, accessibility, and possession all affect the value of information to a manager. In addition, information value depends upon the degree in information accuracy and whether the amount of information is consistent with the manager's needs [that is, neither too little nor too much!].¹¹

Of course, information is generally not free. Acquisition, processing, storage and use of information all incur costs for the firm. As with any other resource, management must make tradeoffs, balancing costs with expected benefits.

Information Managers

To some extent, everyone in organizations manages information. However, some people have more control over the way information is acquired, manipulated, distributed, or used than others. For instance, gatekeepers decide who should receive information—they open and close the gates of information.

Individuals who summarize information or change its form in other ways to make it more understandable or concise are known as **uncertainty absorbers**. They try to make the information more "certain" by taking out unnecessary parts, clarifying issues, bringing together key points, and so on. For instance, some U.S. Presidents have had uncertainty absorbers who read a wide range of newspapers and then put together a collection of key editorials, articles, and other information for the President to read.

Boundary spanners are employees at the "skin" of the organization—the boundary between the organization and its environment. Recruiters and salespeople are boundary spanners. Boundary spanners are often able to gather valuable information about changes in the environment of the organization. Especially when those environments are complex and rapidly changing, boundary spanners are valuable.

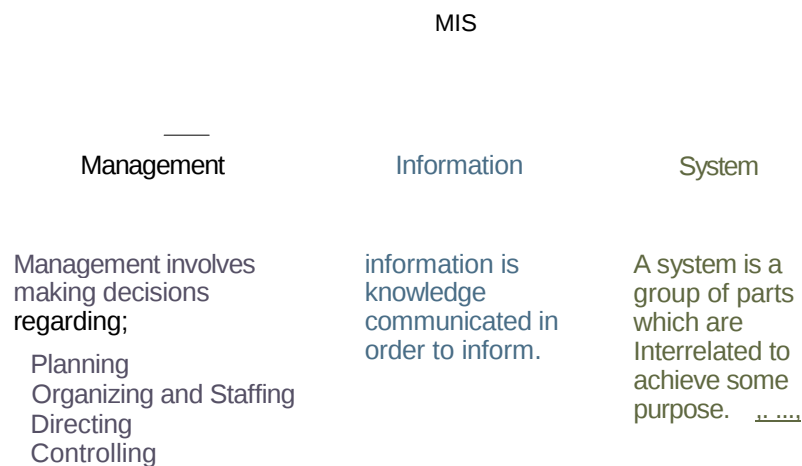
9. R. H. Gregory and R. L. Van Horn, "Value and Cost of Information," in L. W. Knapp, *Systems Analysis Techniques* (New York: John Wiley & Sons, 1989).

Gatekeepers, uncertainty absorbers, and boundary spanners are all information managers. However, their control of information often comes about less because of organizational needs than by personal circumstance. In an attempt to manage the information resource more systematically, many firms are now developing management information systems.

WHAT IS A MANAGEMENT INFORMATION SYSTEM?¹⁰

To organize and exploit information more effectively, many firms are developing management information systems. As shown in Figure 19-1, a **management information system (MIS)** is an integrated system of

Figure 19-1 THE BASIC MEANING OF A MIS



Source: Robert G. Murdick, and E. Ross, *INTRODUCTION TO MANAGEMENT INFORMATION SYSTEMS*, © 1977, p. 8. Adapted by permission of Prentice-Hall, Inc., Englewood Cliffs, NJ,

10. For further discussions of management information systems, see G. B. Davis and M. H. Olson, *Management Information Systems: Conceptual Foundations, Structure, and Development*, 2d ed. (New York: McGraw-Hill Book Co., 1985); I. Ein-dor and E. Segal, "Strategic Planning for Management Information Systems," *Management Science* 84 [1978]: 1631-641; H. C. Lucas, Jr., *Information Systems Concepts for Management*, 2d ed. (New York: McGraw-Hill Book Co., 1982); R. C. Murdick and E. Ross, *Introduction to Management Information Systems* (Englewood Cliffs, NJ: Prentice-Hall, 1977); and J. C. Weatherbe, *Executive Guide to Computer-Based Information Systems* (Englewood Cliffs, NJ: Prentice-Hall,

information flows designed to enhance decision-making effectiveness. Good management information is accurate, timely, complete, relevant in form and content, and available when needed,

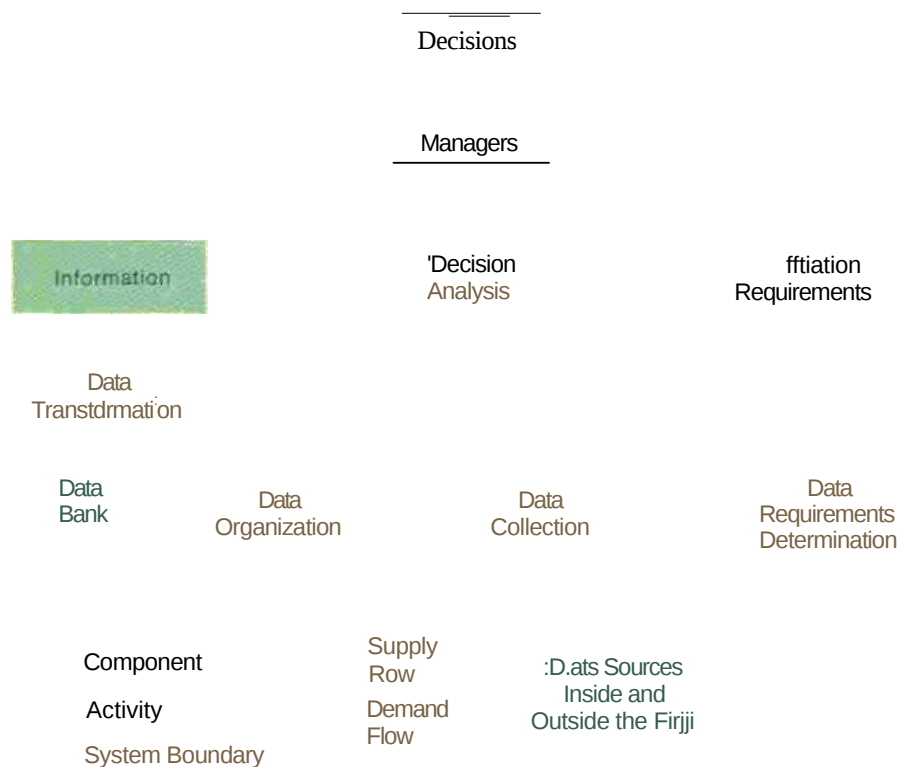
COMPONENTS OF THE MANAGEMENT INFORMATION SYSTEM

Figure 19-2 illustrates a management information system. The figure shows that the MIS is made up of components, activities, and information flows. The components of the MIS are managers, their information requirements, data sources, the data bank, information, and decisions. The activities are the determination of requirements for data, and the subsequent collection, organization, transformation, and analysis of data.

Figure 19-2

THE MANAGEMENT INFORMATION SYSTEM

1



Source: J. C. Carter and F. N. Silverman, "Establishing a MIS/" *Journal of Systems Management* vol. 1 no. 1 (1980), 16. Reproduced with permission.

The demand flow of information occurs when managers indicate that they need information to make a decision. If the information is currently available in the firm's files or computers, it may need only to be retrieved or accessed to be useful. If it is not available, it will need to be collected from any of several data sources, whether within or outside the firm. The supply flow of information refers to the appropriate routing of information to the manager.

DESIGN OF THE MANAGEMENT INFORMATION SYSTEM"

To design an MIS, it is necessary to set objectives, to identify constraints, to determine information needs and sources, and to put the system together.

Setting Objectives for the MIS

Ultimately, the MIS aims to make managers more effective decision makers. They will be more effective to the extent that:

- A They get early warning signals of trouble ahead.
- ▲ They get information to assist in decision making.
- A The system automatically makes certain decisions that don't require managerial input. A Routine clerical operations are automated.

Specific objectives should be set to help managers accomplish these purposes. Figure 19-3 shows how these purposes tie in with MIS objectives and related company objectives. Figure 19-4 presents MIS objectives for some specific functions of the organization, such as purchasing and project control.

Identifying System Constraints

Constraints on MIS design may be externally or internally imposed. External constraints may include government regulations, customer demands, and supplier needs.

One internal constraint is cost. Costs must be compared to anticipated benefits. Too often, information managers simply try to get the

11. This section is based in part on Murdick and Ross, *Management Information Systems*, 8, 147, 149.

figure 19-3 **EXAMPLES, OF MIS OBJECTIVES**

Type	Typical MIS Objective	Related Company Objective
Early warning signals	Prevent surprises due to technological breakthroughs affecting the firm's products	Avoid crash development programs or loss of market share
Decision-assisting; information	Supply financial trends and ratios to management	Make good cash and capital investment decisions
Programmed decision making	Allocating advertising expenditures among selected magazines	Provide economical and broad support for salespersons
Automation of routine clerical operations	Automation of payroll computations	Timely and accurate pay of employees at minimum cost

Source: Robert G. Murdick, Joel E. Ross, INTRODUCTION TO MANAGEMENT INFORMATION SYSTEMS, © 1977, p. 147. Adapted by permission of Prentice-Hall, Inc., Englewood Cliffs, NJ.

Figure 19-4 **OBJECTIVES FOR MIS SUBSYSTEMS**

Subsystem	Objective
Inventory	Optimize inventory costs through the design of decision rules containing optimum reorder points, safety stock levels, and reorder quantities, each capable of continuous and automatic reassessment.
Accounts Payable	Pay 100 percent of invoices before due date.
Purchasing	Provide performance information on buyer's price negotiations with suppliers in order that purchase variance can be controlled within set limits.
Production Control	Identify cost and quantity variances within one day in order to institute closer control over these variables.
Project Control	Identify performance against plan so that events, costs, and specifications of the project can be Diet,

Source: Robert G. Murdick, Joel E. Ross, INTRODUCTION TO MANAGEMENT INFORMATION SYSTEMS, © 1977, p. 149. Adapted by permission of Prentice-Hall, Inc., Englewood Cliffs, NJ.

fanciest, most complete MIS possible, regardless of cost. Policy considerations are another internally imposed constraint. They may determine how centralized the system should be, or may require that certain information be available for internal auditing purposes. Also, the degree of top management support sets limits on the kind of MIS that can be set up. Computer capacity, availability of personnel, and possible reactions of employees affected by the system are other internal constraints.

Determining Information Needs

Once MIS goals and constraints have been identified, the next step is to write a clear statement of information needs. One way to determine these needs is to ask managers what goes on in their decision-making process. Then, questions that must be answered in the process can be determined. Another approach is to ask managers to list their major responsibilities and four or five specific items required to carry out those responsibilities. Typically, various categories of MIS users will have different uses for the systems, as shown in Figure 19-5.

Information needs will also depend on the individual manager. Some managers want great detail; others want less. Some desire a sophisticated, computerized system; others want to "keep things simple." Some say, "Get me all the facts"; others say, "Get me only what I need to know."

Figure 19-5 MAJQE USERS OF A MIS

User	Uses
Clerical personnel	Handle transactions, process input data and answer inquiries.
First-line managers	Obtain operations data. Assistance with planning, scheduling, identifying out-of-control situations, and making decisions.
Staff specialists	Information for analysis. Assistance with analysis, planning, and reporting.
Management	Regular reports. Ad hoc retrieval requests, analyses, and reports. Assistance in identifying problems and opportunities. Assistance in decision-making analysis.

Source: From *Management Information Systems: Conceptual Foundations, Structure, and Development*, 2nd ed., by G. B. Davis and M. H. Olson. Copyright © 1985 by McGraw-Hill Book Company. Reproduced with permission.

The nature of the organization and its environment is also important in determining information needs. In general, the larger and more complex the firm is and the more complex and rapidly changing its environment, the more sophisticated its information needs will be. And, in "looser," more organic sorts of organizations, it may be harder to determine information needs than in a very structured, mechanistic firm.

Determining Information Sources

Once information needs are determined, sources can be identified. Some of these are primary data sources. Data from these sources are gathered specifically for the current purpose. Others are secondary sources. Data from these sources were initially collected for other purposes, but fit the current needs. Two secondary data sources are internal records and published sources of business information.

There is often a surprising wealth of information available in the firm's own internal records. For instance, purchase orders may give data about which market segments are growing or declining. Personnel files can be used to see whether there is especially high turnover in certain areas of the firm, or whether some groups of employees are being promoted faster than others. Memos, letters, and various records of inputs and outputs of the firm may all prove useful.

Much of the information that businesses need may be found in the library. Newspapers, magazines, annual volumes of data, and many other sources provide information concerning just about every imaginable topic of interest to management.

Putting the System Together

As a final step, the system must be put together. This usually involves charting the needed flows of information, such as marketing and sales information and reports, and determining which information should be stored in data banks. Then decisions are needed concerning how inputs to the MIS, such as personnel information, will be coded and what form they will be taken by system outputs. Finally, computer hardware and software needs, discussed in the previous chapter, must be assessed.

Other Issues in MIS Design

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Here are some additional issues relating to MIS design which have recently generated interest. They address the need for user involvement in MIS design as well as the roles of technology, user individual differences, and management level.

The Need for User Involvement. A recurring theme in the MIS literature is the need for user involvement. The logic underlying this theme is that the technicians who develop an MIS often have different perspectives and attitudes from those of users, and that such differences may result in shortcomings of the system.¹² It has been argued, for instance, that "in relation to other factors, e.g., top management support, competence of EDP [Electronic Data Processing] staff, and quality of goal setting, user involvement seems to be the only one which is consistently related to the quality of final outcomes."¹³ Other statements, such as "User participation is critical to the success of the MIS project"¹⁴ and "There is too little involvement in developing a system and too little ownership of the resulting system,"¹⁵ echo this view. However, a recent review of relevant research by Blake Ives and Margrethe Olson (1984)¹⁶ suggests that this view is not yet supported by convincing empirical research. As Ives and Olson note, though, their review should not be taken to mean that user involvement is unimportant, only that it has not been properly documented.

The Role of Technology. Richard Daft and Norman Macintosh (1978) have argued that organizational technology must be considered when designing and implementing information systems. In particular, they reason that two technological dimensions—task variety and task knowledge—are crucial. Task variety is the frequency of unexpected and novel events that occur as inputs are transformed into outputs. Task knowledge is the degree to which the transformation process is well understood. As shown in Figure 19-6, Daft and Macintosh feel the MIS should fit these technological dimensions.

If, for example, the technology is well understood and there is little task variety, as in programmable technology, a concise information system is appropriate. In such a system, small to moderate amounts of precise and unambiguous information are available to users and the information is used in a quick and decisive way. At the other extreme, if the technology is not well understood and task variety is high, a diffuse infor-

12. K. Kaiser and A. Siinivasan, "User-Analyst Differences: An Empirical Investigation of Attitudes Related to Systems Development," *Academy of Management Journal* 25 (1982): 630-31.

13. B. DeBrabander and A. Edstrom, "Successful Information Systems Development Projects," *Management Science* 24 (1977): 191.

14. R. F. Powers and C. W. Dickson, "MIS Project Management: Myths, Opinions, and Reality," *California Management Review* 15 (1973): 15-6.

15. K. C. Lucas, Jr., "The Evolution of an Information System: From Key-Man to Every Person," *Sloan Management Review* vol. 19, no. 2 (1978): 43.

16. The literature on participation in decision making, discussed in Chapter 14, suggests that user involvement should lead to greater understanding and acceptance of the MTS. Further, the participation literature—and Ives and Olson—would argue that such involvement is especially important when the situation is poorly structured and when acceptance is important. You may want to refer back to the Vioora model in Chapter 14 for clarification of this point.

Figure 19-6

AND INFORMATION SYSTEMS



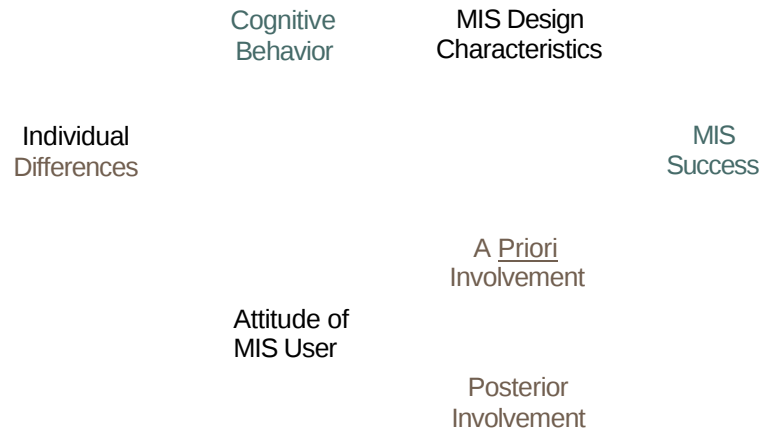
Source: © 1978 by the Regents of the University of California. Adapted from CALIFORNIA MANAGEMENT REVIEW, volume 21, no. 1, p. 87 by permission of the Regents.

mation system fits best. A diffuse MIS is characterized by moderate to large amounts of information covering a wide range of material. The information is frequently ill defined and imprecise, and is typically used in a slow, deliberate manner.

The Impact of User Individual Differences. The issue of whether user individual differences should or do play roles in the design, implementation, or usage of management information systems is controversial. In addressing this issue, researchers have explored user cognitive, personality, and demographic characteristics, as well as situational variables.

Figure 19-7 presents one model which links user individual differences to ultimate MIS success. The upper path in that model, a cognitive

Figure 19-7 **IMPACT OF INDIVIDUAL DIFFERENCES UPON MIS SUCCESS**



Source: Reprinted by permission of Robert W. Zmud, "Individual Differences and MIS Success: A Review of the Empirical Literature," *MANAGEMENT SCIENCE*, vol. 25, no. 10 [October 1979]. Copyright 1979 by The Institute of Management Sciences.

path, suggests that individual differences influence managers' information-processing and decision-making behavior. They in turn impose or suggest MIS design alternatives directed toward motivating or facilitating MIS use. The lower path, an attitudinal path, reflects the impact of individual differences on the attitudes of potential MIS users and on the tendencies for MIS users to involve themselves in the MIS developmental effort.

This figure suggests that there are at least two reasons for considering user individual differences in MIS design. First, various users may have different decision styles and thus different information needs. Second, some users may want to contribute to MIS design and subsequent refinement while others may not.

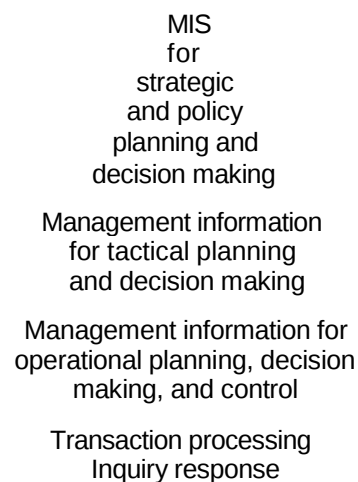
Robert Zmud reviewed empirical evidence relating to these issues. He concluded that "analysis of the literature regarding the influence of individual differences upon MIS success indicates rather clearly that individual differences do exert a major force in determining MIS success. It is just as apparent, however, that much remains unknown regarding the specific relationships involved and the relative importance of individual differences when contrasted with contextual variables."¹⁷

17. R. W. Zmud, "Individual Differences and MIS Success: A Review of the Empirical literature," *Management Science* 25 J1979): y75. This issue is far from resolved. Georgr

Information Needs by Management Level. As shown in Figure 19-8, management information needs vary by level in the organizational hierarchy. At upper levels, information is needed for strategic and policy planning and decision making. At middle levels, information needs focus on tactical and operational planning and decision making. At lower levels, those needs relate to more routine activities, such as transaction processing.

Figure 19-8

MANAGEMENT INFORMATION! BY ORGANIZATIONAL LEVEL



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Huber in "Cognitive Style as a Basis for MIS and DSS Designs," for instance, has argued that considering cognitive style in MIS design—a favorite target of study—is "much more than nothing." [V. 567]. For more on this issue, see I. Benbasat and R. N. Taylor, "The Influence of Cognitive Styles on Information System Design," *MIS Quarterly* (June 1978), 43-63; and Olson, *Management Information Systems*; Kaiser and Srinivasan, "User-Analyst Preferences"; D. Robey, "User Attitudes and Management Information System Use," *Academy of Management Journal* 22 [1979]: 527-38; D. Robey and W. Taggart, "Measuring Minds: The Assessment of Style in Human Information Processing," *Academy of Management Review* (1981): 375-83; _____, "Issues in Cognitive Style Measurement: A Reply to Schwabger," *Academy of Management Review* 8 (1983): 152-55; and D. M. Seta, "Measuring Managers' Minds: A Critical Reply to Robey and Taggart," *Academy of Management Review* & {1983}: 143-51.

G. Anthony Gorry and M. S. Scott Morton (1971)¹⁸ have described more specifically how information requirements differ for various classes of managerial activity. Their framework is presented in Figure 19-9.

Figure 19-9 INFORMATION CHARACTERISTICS
BY AREA OF MANAGEMENT DECISION

Characteristics of Information	Operational Control	Management Control	Strategic Planning
Source	Largely internal		External
Scope	Well defined, narrow.....		Very wide
Level of detail	Detailed		Aggregate
Time horizon	Present		Future
Age	Highly current		Quite old
Accuracy	High.....		Low
Frequency of use	Very frequent.....		Infrequent
Type	Quantitative	Qualitative	

Source: Keen and Scott Morton, *DECISION SUPPORT SYSTEMS*, 1978, Addison-Wesley, MA. Page 82 (adapted material). Reprinted with permission. Reading,

As shown in that figure, strategic planning is generally future oriented and requires a wide variety of information, much of it from external sources. The information is often qualitative and lacks great detail. By its nature, it often suffers from low degrees of accuracy. In contrast, operational control, the process of ensuring that specific tasks are efficiently and effectively carried out, requires highly accurate, detailed, current information. The information is typically quantitative, narrow in scope, and drawn from internal sources. Information for management control generally falls at intermediate levels on these dimensions.

ADDITIONAL GUIDELINES FOR MIS SUCCESS

Several authors have presented additional guidelines for successful MIS design and implementation. Here are some of those guidelines:¹⁸

18. These are drawn primarily from f. O. McClain and L. f. Thomas, *Operations Management: Production of Goods and Services* (Englewood Cliffs, NJ: Prentice-Hall, 1985), 215; and Weatherbe, *Computer-Based Information Systems*, 151. The first point is empirically demonstrated by P. H. Cheney and G. W. Dicksan, "Organisational Characteristics and Information Systems: An Exploratory Investigation" *Academy of Management Journal* 25 (1982): 170-84.

Behavioral skills are crucial for MIS design. If user needs and sources of resistance are not considered, trouble is likely. Different users require different information. The information system must be designed to assist particular managers. If system outputs are not what users want, they will be ignored or berated.

To the greatest extent feasible, an information system should be designed in a compatible way throughout the organization. Information systems should be tested and evaluated prior to implementation. Any "bugs" that remain after implementation may lead to errors, frustration, and—perhaps—calls to scrap the system.

The development and implementation schedule should be realistic.

Systems clarity should be striven for by keeping systems as simple as possible and providing adequate training. Changes in job content resulting from new information systems should be recognized and adjusted for. In particular, job evaluations and accompanying reward systems should be modified to reflect job changes.

Management information systems must be tailored to the¹ organization. Organization structure and technology influence proper MIS design. Attempts simply to transfer a system from one organization to another are probably misguided. Managers should not expect a "final" system to be put in place immediately. The implementation process will almost certainly be evolutionary.

DECISION SUPPORT SYSTEMS

The term **decision support system (DSS)** refers to a class of systems which support the process of making decisions. They are a type of application that allows the manager to ask a series of "what if" questions about the problems they face.

DSS Assumptions

The idea of a DSS is based on certain assumptions about the **role** of the computer in decision making. Here are four key assumptions:¹⁹

19. Davis and Olson, *Management Information Systems*, 368-69. For more on decision support systems, see G. P. Huber, "Decision Support Systems: Their Present]

- A A DSS *supports* the manager but does not *replace* the manager. This emphasis on enhancement of decision making exploits those aspects of computers and analytical techniques that are appropriate for the problem and leaves the remainder to the manager.
- ▲ A DSS is likely to be most helpful for *semistructured* problems, in which parts of the analysis can be systematized for the computer, but the decision maker's insight and judgment are needed to control the process. Many problems in organizations fall into this category,
- ▲ The term *system* in decision support system suggests that effective problem solving is *interactive*, employing a dialogue between managers and machines.
- A A DSS is more a service than a product. Since the problem can be only partially structured, and since managers grow in their understanding and needs over time, a *DSS must grow and s eke user adapts a&d le*

DSS Subsystems

Decision support systems provide tools *to* managers which they *can* use to help them to analyze problem situations systematically. They have four subsystems:²⁰

- A Interactive capability which enables the user to communicate *directly with the system*.
- A A data manager that makes it possible *to* extract necessary *information* from *both internal and external* databases.
- A A modeling *subsystem that permits the user to interact with* management science models by inputting parameters and tailoring situations to specific decision-making needs.
- A An output generator with graphics capability which provides the user with the capability to ask "what if" questions and obtain output in easily interpretable form.

An example of how such a system is used at Northwest Industries is provided in Situation 1.

and Future Applications." In G. R. Ungson and D. N. Braunstcin, eds., *Decision Making: An Interdisciplinary Inquiry* (Boston, MA: Kent Publishing Company, 1982); R. J. Spraguc, Jr., and E. D. Carlson, *Building Effective Decision Support Systems* [Englewood Cliffs, NJ: Prentice-Hall, 1982]; and D. R. Wagner, "Decision Support Systems: Computerized Mind Support for Executive Problems," *Managerial Planning* 30 [19KI]: 9-16.

20. R. D. Anderson, D. J. Sweeney, and T. A. Williams, *An Introduction to Management Science*, 4th ed. [St. Paul, MN: West Publishing Company, 1985], 722.

SITUATION 1

The CEO Goes On-Line

Executives at Northwest Industries (1980 sales: \$2.9 billion) use an information system to access data to perform analysis and modeling. The development of this system began in 1976 when Bob Heineman, president and chief executive of Northwest, decided that he needed a specially tailored database to aid him in monitoring, projecting, and planning the progress of his nine operating companies. Heineman wanted to be able to analyze various aspects of the business himself but saw little opportunity to do so without a computer-based system to reduce data-handling chores.

In January, 1977, the six top executives at Northwest were given access to an experimental system through which they could retrieve more than 70 reports and perform such limited analyses as compound growth calculations and trend projections. By February, Heineman had reached the limits of the system's capabilities and was demanding more.

Additional capabilities were provided by an access and analysis language, EXPRESS, which facilitated not only simple file handling and data aggregation, but also extensive modeling and statistical analyses of data series. To complement these improved capabilities, Northwest has since added to its executive database 350 financial and operational items of data: planned, budgeted, forecasted, and actual monthly results for each operating company for the past eight and the next four years. It has also added 45 economic and key ratio time series and several other databases.

Northwest's Executive Information System (EIS), with its extensive, continually growing database, is now used by almost all managers and executives to perform their monitoring and analytic functions. But the driving force behind the system and its most significant user remains Heineman. With the system is an everyday thing for him, a natural part of the job,

"There is a huge advantage to the CEO to get his hands dirty with data," he says, because "the answers to many significant questions are found in the detail. The system provides me with an improved ability to ask the right questions and to know the wrong answers." What is more, he finds a comparable advantage in having instant access to the database to try out an idea he might have. In fact, he has a computer terminal at home and takes it with him on vacation.

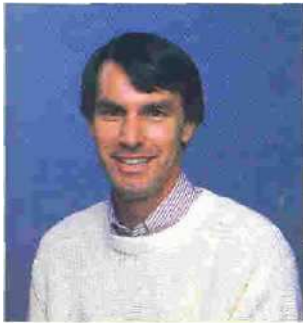
Source: Reprinted by permission of the *Harvard Business Review*, Excerpt (reprinted) "The CEO Goes On-Line" by John F. Rochart and Michael E. Treacy (January-February 1982). Copyright © 1982 by the President and Fellows of Harvard College; reserved.

DSS Goals

Decision support systems aim at increasing managerial effectiveness through an interactive, supportive, evolving process. Steven Madi-

Academic Profile

DANIEL ROBEY



Daniel Rubey (D.B.A., Kent State University) is Professor of Management at Florida International University. He is author of *Designing Organizations*, coauthor of *Managing Computer Impact: An International Study of Management and Organizations*, and coeditor of *Organization Development: Progress and Perspectives*. Professor Robey's many articles on information systems, innovation, task design, cognitive style, and other issues have appeared in a variety of key management and information systems journals. He has served on the editorial review boards of the *Academy of Management Review* and the *Journal of Management* and in a variety of leadership positions in professional organizations.

Q: Why should firms, be concerned with MIS?

A: I like the term "information systems" (IS) better than MIS because many applications of the technology do not directly affect management decisions. For example, office automation and communication systems help to make organizations more effective, but they are indirectly concerned with management. Firms should be concerned with IS because IS supports a number of important organizational functions. Strategic planning, operations, decision making, communication, and control are all affected by computers and IS. One problem is that many managers consider computers to be too technical and don't bother learning anything about them. This is unfortunate because managers are best equipped with the vision to understand the most productive uses of IS. Managers who resist IS because of the technical barrier cannot make good decisions about their use, and are less effective as a result.

Q: Are information systems primarily useful only for large organizations?

A: No. Historically, larger organizations have been the ones that could easily make the capital investment required. However, the past ten years have seen the so-called micro revolution in computers. Now, very small organizations and independent professionals are using small computers for many of the functions mentioned above. Q: There is some controversy concerning whether or not individual differences should be considered when designing an IS. How would you summarize your views on this issue?

A: Individual differences in preferences may be related to user satisfaction in working with an IS. For instance, people who prefer "the big picture" may dislike detailed tabular displays and feel more comfortable with graphs that portray overall patterns. Individual differences in ability may be

related to performance differences, for example, color graphic displays help some people with perceptual limitations to perform better than they do with monochrome displays.

One problem with these generalizations is treating individual differences too rigidly. The human nervous system is a very flexible information processor in its own right, and very capable of adjusting to the different demands placed upon it. I don't think that individual differences should be used to deny some people the opportunity to work with computers or to hold certain jobs where computing is necessary. That would be unfair discrimination. Perhaps the best way of dealing with individual differences is to make systems flexible in the options they offer to the user. Q: How would you characterize the current state of decision support systems? Do you think they will take on a larger role in the future?

A: Most DSS continue to support rather structured decision processes despite claims that DSS fit unstructured problems. DSS depend on mathematical models and sufficient databases to make the models run. In many cases managers have neither models nor data, and I look for DSS in the future to be expanded to include even less structured situations where real creativity is needed."

In this capacity, DSS could be used to probe the human mind with questions rather than giving answers to inquiries. A DSS could help managers move away from conventional thinking by introducing surprise questions at just the right moment. DSS can also be applied to group problem solving by assisting in the combination of judgments of group members. I see DSS as having an exciting future, as long as DSS designers understand the potential of information technology to support the creative aspects of human problem solving.

has suggested that DSSs may enhance effectiveness in at least two ways.²¹

- ▲ *Improving personal efficiency.* At a minimum, a manager with a DSS may be able either to perform the same task in less time or to perform the same task more thoroughly in the same amount of time. More optimistically, increased efficiency may mean that a person is performing a more appropriate task in a different way and using less time and effort.
- ▲ *Expediting problem solving.* A DSS may ease problem solving by permitting fast access to required data, by improving consistency and accuracy, and by providing better ways of viewing problems.
- ▲ *Facilitating interpersonal communication.* DSSs may facilitate interpersonal communication in a number of ways. For example, they provide standardizing mechanics and vocabulary. In large, complex organizations terms may have different meanings across divisions. A DSS defines terms and procedures in standard ways. Also, a DSS provides a conceptual basis for decision making. That is, it can combine separate potential decisions by various people by filtering those decisions through a single model that would estimate the total result. For instance, production, marketing, and finance managers could use the model to demonstrate the "objective" effects of one group's proposals on other groups' actions and on the total outcome.
- ▲ *Promoting learning or training.* Users of a DSS gradually learn the concepts incorporated in the models. In fact, some companies are now explicitly using DSSs as training tools.
- ▲ *Increasing organizational control.* Some DSSs have been extended to provide data for purposes of overall organizational control. For instance, the systems may be used to automatically develop reports comparing managers' decisions to those standard formulas. Of course, in many situations where judgments required, standard formulas are not available.

There have been many impressive examples of savings and benefits derived from decision support systems. For instance, a fuel management allocation application developed by National Airlines saved the firm \$500,000 in the first month of operation. The airline stores data on fuel prices and availability along with storage costs and capacities at 130 cities it serves. The performance and tentative monthly itinerary also included for each of its 56 aircraft. In fifteen minutes the computer

21. This listing is condensed from S. L. Alter, *Decision Support Systems: Practice and Continuing Challenges* (Reading, MA: Addison-Wesley, 1980), 95-104.

produces a list of the best fueling stations and vendors for each flight, a task that previously took a month to perform manually.²²

DECISION INSIGHT SYSTEMS

One interesting recent MIS-related development has been dubbed the decision insight system.²³ Unlike a decision support system, which is typically developed for a specific application, the **decision insight system** is aimed at improving decision making in general. That is, its purpose is to lead the manager through the problem-solving process. Such systems are especially useful in ill-structured decision situations.

An **ill-structured**, or **wicked**, **decision situation** may be described as non-routine and unprogrammed, with delayed feedback and incomplete information.²⁴ While clearly a difficult situation to be in, it is typical of many management decisions, especially those at higher, strategic levels. In ill-structured situations, the speed, reliability, lack of emotion, and memory of the computer may serve as valuable complements to the abilities of the human decision maker.

Several decision insight systems have been developed. For instance, STRATANAL (for STRATegic ANALysis) "leads the analyst through a decision process of choosing the right mix of factors for an efficient organizational strategy."²⁵ CONCORD (for CONference COoR-Dinator) is a program designed to tutor groups in general strategies for problem solving.²⁶ DECAID (for Decision Aid) is a collection of heuristic programs to assist in management education and actual strategic management decisions.²⁷

One common element of such programs is their general focus; that is, they are each applicable to a broad range of problems. As such, they do

22. *Business Week*, [January 21, 1980], 74.

23. There is considerable confusion over terminology in the MIS area. The term *decision insight system* is suggested by B. Golden, A. Hcvner, and D. Power, "Decision Insight Systems for Microcomputers: A Critical Evaluation," *Computers and Operations Management* (volume 13, #s 2-3). It is used here to differentiate these systems from decision support systems which rely on data bases, are task specific, and are less applicable to ill-structured situations.

24. C. Churchman, "Wicked Problems," *Management Science* 14 [1967]: B141-B142,

25. R. Joyner and K. Tunstall, "Computer Augmented Organizational Problem Solving," *Management Science* 17 (1970): B211-B225.

26. F. T. Paine and W. Naumes, *Organizational Strategy and Policy* (Philadelphia: W. B. Saunders Company, 1978)

27. D. T. Power, "Design and Development of DECAID: A CAL Decision Formulation Program," unpublished masters thesis (University of Iowa, 1977); and D- l. Power, G. Rose, and W. P. Valliere, "BASIC DECAID." Paper presented at the national meeting of the Academy of Management 1978.

not contain databases. Another common element is their complex, tree-like structure. They contain a series of branching instructions to lead the manager through the problem-solving process. For instance, DECAID can be used to address any problem situation (though it is especially helpful when the situation lacks structure). It has stages that help the manager to define the problem, generate alternatives, evaluate the alternatives, make a choice, question the desirability of the choice, and so on.

EXPERT SYSTEMS

An expert system is a computer application that guides the performance of ill-structured tasks which usually require experience and specialized knowledge (i.e., expertise). Using an expert system, a non-expert can achieve performance comparable to an expert in that particular domain. Expert systems are a sort of decision support system. A distinguishing characteristic is the knowledge base, the data and decision rules which represent the expertise.²⁸

These expert systems often rely on artificial intelligence (AI). With artificial intelligence, a computer can reason as people do, as well as learn from experience and communicate in human language. Complete artificial intelligence has not yet been achieved, but developments are promising. For instance, an expert system named PROSPECTOR was used to find a rich deposit of molybdenum ore buried deep under Mount Tolman in eastern Washington. While geologists had long been convinced that the ore existed, over 60 years of mining and drilling had failed to yield pay dirt. Written into PROSPECTOR'S software was the accumulated knowledge of nine geologists who were intensively interviewed about how to locate minerals from what they observe in the field. This information was reduced to a series of rules and combined with a huge storehouse of geological information. When PROSPECTOR was told to locate the ore, it asked a series of factual questions about the Mount Tolman area. After considering all the answers, it pinpointed the ore in a small, unexplored area that was ringed by earlier borings and mines.²⁹

Many applications of expert systems are now being reported,³⁰ and in time, expert systems may well become more common than people I

H.I

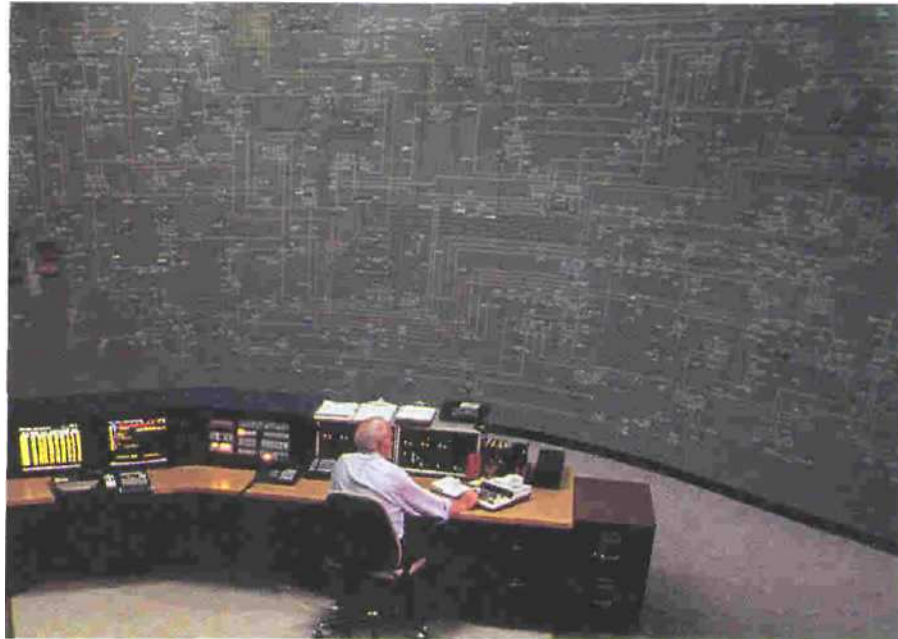
28. Davis and Olson, *Management Information Systems*, 375. For more on expert systems, see F. Hayes-Roth, D. A. Waterman, and D. B. Lenat, *Building Expert Systems* (Reading, MA: Addison-Wesley Publishing Co., 1983).

29. *Business Week* (July 9, 1984), 54-55.

30. *Ibid.*, 54-62.

factory floors. They will be the brains that make robots intelligent and flexible. And they will assist engineers and managers in such diverse tasks as designing products, supervising orders and inventories, and coordinating production. An expert system at Hewlett-Packard Co. advises how to manufacture integrated circuits, while at Digital Equipment Corp., an expert system manages scheduling on the shop floor.

Expert systems are not without problems, but they offer great promise for the future.



American Telephone & Telegraph Co.'s expert system called ACE quickly locates faults in telephone cables. It does in an hour a job that previously took a team of technicians a week to accomplish. Digital Equipment spent two years building an expert system that its salespeople use to configure computer systems for their customers. The system has cut error rates from 25 percent to 5 percent, at an estimated annual savings of more than \$ 10 million. Expert systems are also ideally suited to a variety of insurance underwriting and banking tasks, to medical diagnosis, and to almost any other area where expert judgment plays a role.

There are problems associated with expert systems. For one, they are difficult to develop, sometimes requiring several person-years of effort and millions of dollars. Further, it is generally not easy to capture an expert's knowledge to incorporate in such programs. Experts may use complicated problem-solving techniques of which even they are not consciously aware. These problems notwithstanding, expert systems are a promising and exciting new development.

OVERCOMING RESISTANCE TO INFORMATION TECHNOLOGY

Since they are typically computer-based, management information systems and related information technology face many of the same sorts of opposition as other computer applications. There are concerns, for instance, that privacy will be invaded, jobs will be lost, the workplace will be dehumanized, and old skills will be rendered useless. Some people, as the following cartoon suggests, are overwhelmed by the apparent complexity of MIS hardware and software.

DOONESBURY

by Garry Trudeau



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Source: DOONESBURY. Copyright 1982 by G. B. Trudeau. Reprinted with permission of Universal Pff, Syndicate. All Rights Reserved.

Further, like any major change, introduction of a MIS creates uncertainty and, often, feelings of manipulation. As a result of such concerns, many managers simply try to ignore a system or avoid using it. Others use the system as a convenient scapegoat, blaming it for problems that occur. Still others attack the system, trying to "beat" it. There have been at least four cases of people actually shooting computers—in one instance, because a terminal would not stop spewing out information.³¹

Such extreme reactions notwithstanding, these are not irrational fears, and they should be treated with respect and caution. Attempts should be made to explain the reasons for the system, including its benefits to employees. The probable impacts of the change on rewards, and social relationships should be assessed and, if feasible, addressed.

31. Weatherbe, *Computer-Based Information Systems*, 145.

should be made to minimize harmful impacts. Change should be introduced as painlessly as possible, perhaps through a gradual phasing-in process. Further, as with other change, if employees are allowed to participate in the MIS implementation process, they are more likely to understand and accept the change. Thus, user involvement in the MIS development process should reduce resistance.

THE IMPACT OF MIS

MIS may impact at many levels—societal, industry-wide, organizational, and individual. At the societal level, for instance, Alvin Toffler has argued that developments in MIS may cause demassification, in which mass production gives way to such things as the growth of home industries. At the industry level, MIS is influencing the nature of competitive strategies. For instance, airlines are working together with one another and with hotels, customers, and others in large airline reservation systems.³²

At the level of the organization, MIS may influence organizational structure and flexibility as well as, one would hope, performance. As an *example of impact on structure*, some people *will* be displaced by management information systems, changing the nature and shape of the organization. The ease with which executives will be able to access and process information will permit them to manage with fewer middle managers.³³ It is interesting that information technology provides the opportunity for both centralization and decentralization—centralization because top managers have the information to exert control more easily and decentralization because decision making can be more easily delegated when information is readily available at lower levels.

The probable impact of MIS on individuals, has been hotly debated. For instance, Chris Argyris [1971] argued that the rationalization and systemization of management information systems threatens the individual and also inhibits the openness and adaptiveness essential for a healthy organizational climate. He argued further that MIS reinforces the status quo and generates forces that favor efficiency over effectiveness. Others have taken a more positive view of the consequences of information technology. Especially when user needs are taken into consideration

32. For more on how information technology is impacting on competitive strategies, see F. W. McFarlan, "Information Technology Changes the Way You Compete," *Harvard Business Review* [May-June 1984], 98-103; and G. L. Parsons, "Information Technology: A New Competitive Weapon," *Sloan Management Review* [Fall 1983], 3-13.

33. For an interesting discussion of alternative scenarios about organizational impacts of information systems, see D. J. Power, "The Impact of Information Management on the Organization: Two Scenarios," *MIS Quarterly* vol. 7, no. 3 (1983); 13-20.

in information system design and changes are humanely introduced, individual reaction to information technology can be quite positive.³⁴

IMPLICATIONS FOR MANAGEMENT

It would be inconceivable for a firm to ignore such resources as personnel, materials, and finances. Until recently, though, information was the neglected sibling of the resource family. This situation is rapidly changing. The impact of information and information systems on organizations and their members can hardly be overestimated, and all indications suggest that such impact will continue to grow.

There is an old Chinese curse, "May you live through interesting times." Information technology is certainly creating interesting times for organizations. Some will see such interesting times as a curse and others as a challenge. Those who try to understand information technology and attempt to use it are likely to reap considerable benefits including, possibly, power. Those who attempt to avoid or ignore it may develop frustration and resentment.

Like other resources, information must be used intelligently and managed carefully. Just as an inventory control system or a human resource development system is designed to fit a particular organization with its own specific characteristics, so must an information system be tailored to the particular situation. Organizational structure, technology and context should all be evaluated in designing and implementing a MIS.

Further, information systems represent a major social change as well as a remarkable technological development. As with any social change, the human factor must be considered. Since changes in information technology impact directly on members of organizations, and since the acceptance of that change is crucial to its success, the needs of MIS users must be considered if the MIS is to be successful. In many cases, user involvement in the design and implementation process may be necessary.

Information technology is presenting exciting new options to managers, some of which are just becoming apparent. With decision support systems, managers can draw on extensive databases and sophisticated models to help answer important "what if" questions about their problems. Decision insight systems permit them to structure the decision process in ill-structured, wicked decision situations. With expert systems, they can draw on the powers of artificial intelligence and wisdom of experts to develop high levels of competence quickly,

34. For more on this point, see Keen and Scott Morton, *Decision Support Systems*

Information technology is frequently met with resistance, often based on genuine concerns about its consequences. Such resistance must be dealt with intelligently. Harmful impacts should be anticipated and minimized, and clear explanation of the reasons for and consequences of the change should be presented.

The impact of management information systems and related information technology is really just beginning to be felt. It is already clear that basic changes at the levels of society, industries, organizations, and individuals will result. The organizations you will manage will be fundamentally different from those of 20 years ago and, quite likely, those of today. Welcome to interesting times.

KEY TERMS AND CONCEPTS

artificial intelligence (AI)
boundary spanners decision
insight system decision
support system
(DSSf)
demand flow of information
expert system gatekeepers
ill-structured or wicked
decision situation
information

information resource
management knowledge
base management
information
system 1MIS) primary
data sources secondary
data sources supply flow
of information task
knowledge task variety
uncertainty absorbers

REVIEW QUESTIONS

1. In what ways is information a resource?
2. How do information needs vary by type of management decision?
3. What is a management information system?
4. List the steps in designing a MIS. /
5. Why do some people resist the introduction of management information systems?
6. Give four key assumptions about the proper role of a decision support system.
7. Identify the special characteristics of a decision insight system.
8. What is an expert system? When is it useful?

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CASE 19 A Information and Timing

Of the thousands of phone lines at Merrill Lynch & Co.'s trading desks, seven are confidential. Only the chief of block trading uses them when he wants information fast, without alerting anyone else in the trading room. Several of them go straight to New York's biggest banks. Another line reaches Merrill Lynch's chairman, William Schreyer. And one line goes to the firm's most powerful customer: Michael Steinhardt.

When Merrill Lynch phones Mr. Steinhardt, it reaches a pudgy 45-year-old in a polo shirt who can sometimes be found eating Japanese takeout food at his desk. But appearances deceive; Mr. Steinhardt has built up one of the nation's most feared and respected private investment firms. Last year, Steinhardt Partners earned as much as 56 percent on its portfolios, nearly double the market's gain. Assets have surged to more than \$600 million including at least \$50 million of Mr. Steinhardt's own money.

Much of Mr. Steinhardt's clout comes from his rapid-fire—and sometimes controversial—trading. He will buy a stock in the morning, then sell it two hours later at a profit. He spends \$22 million a year in brokerage commissions, putting him in the same league as the biggest institutions.

Brokers salivate for these commission dollars. As a result, Wall Street's top firms gladly swap market insights with Mr. Steinhardt several times a day. "Sometimes his market intelligence is better than ours," says a Merrill Lynch executive.

Gorry, G. Anthony, and Scott Morton, M. S. 1971. A framework for management information systems. *Sloan Management Review* (Fall), 55-70. Ives, B., and Olson, M. H. 1984. User involvement and MIS success: A review of research. *Management Science* 30:586-601. Mintzberg, H. 1975. The manager's job: Folklore and fact. *Business Review* 53:49-61.

Harvard Business School

A look at Mr. Steinhardt's recent trading shows how he combines intensity, charm, and a far-reaching information network to make profits. From his 33rd-floor office in midtown Manhattan, he storms into dozens of different stocks. And in case an informant passes on what Mr. Steinhardt calls "fancy information"—a tip that helps him make \$90,000 in an afternoon trading.

All through the day, phone calls bring Mr. Steinhardt the news he needs. Other investors study annual reports, read trade journals, or visit companies to get investment ideas. Not Mr. Steinhardt. He thinks the last time he visited a company was 1973. Instead, he munches on bran muffins and hears daily from Wall Street personalities.

Mr. Steinhardt's office layout reveals his fondness for split-second decisions. Instead of a normal desk, Mr. Steinhardt sits at the helm of an L-shaped trading juggernaut. Six video screens surround him. They churn out a running tape of stock trades, the latest headlines, and prices of more than securities he owns. No matter what Steinhardt discusses, one eye is the screens.

Above all, Mr. Steinhardt wants profits. With an ear to the rumor mill last summer, he bought at least 250,000 shares in General Foods Corp. just before Philip Morris agreed to acquire the company. "We're nimble enough that we can quickly ill-

200,000 shares if something seems to be happening," an aide says.

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1. In what ways is information a resource to Mr. Steinhardt:

2. Analyze the information acquired by Mr. Steinhardt in terms of the dimensions presented in Figure 20-10. Are the characteristics appropriate to the task?
3. Does Mr. Steinhardt have a management information system? Why or why not?