

COMPUTER

APPLICATIONS

IN

MANAGEMENT

Give reasons why computers are useful.

- A Trace the history of the development of computers.
- A Describe modern computers.
- A Explain computer hardware and software.
- A Discuss computer applications in management.
- A Describe uses of microcomputers in business.
- A Identify problems with computers.

Time magazine's Man of the Year for 1982 was not a man, woman, or child. The contributions of any individual, *Time* concluded, were small in comparison to the contributions of the computer—*Time's* choice for 1982's "greatest influence for good or evil."

In the years since that selection, the computer's potential for good and evil has begun to be realized. Computers are providing the opportunity for personal growth and autonomy at work, but they are also increasing tedium and resulting in tighter, sometimes stifling, control. They are creating jobs for people who would otherwise be homebound, but at the same time they are making many other workers unnecessary. They are easing access to needed information, but are threatening privacy. They are valuable tools for decision making and handy aids for sabotage and larceny. They are everywhere, and they are not going away.

In this chapter, we will examine the nature of computers and see why they are used. We will trace their development and consider modern computer hardware and software. We will examine computer applications for job design, staffing, decision making, control, operations management, data processing, and word processing. We will then consider the growing use of microcomputers in business. Finally, we will address a variety of potential problems associated with the use of computers in organizations.

THE NATURE OF COMPUTERS

Let's first consider two questions: What are computers? Why are they used? The answers to these basic questions provide the foundation for the remainder of the chapter.

After studying this chapter, you should be able to:

A

What Is a Computer?

A **computer** is a machine that can carry out complex and repetitious operations at very high speeds. It receives data and instructions, processes the data into required information, and provides results in a form that can be read by a person or another machine.

There are two types of computers, analog and digital. The **analog computer** uses electrical circuits to simulate the behavior of other types of physical systems. For instance, an appropriate electrical circuit could be used to create the likeness of a physical system of masses and forces. The **digital computer** computes with digits; that is, with numbers. Since the analog computer is almost always used for engineering rather than for business applications, we will focus in this chapter on the digital computer.

Why Use Computers?

Computers have at least five advantages over the human decision maker. First, computers are fast: The speed of some modern computers is measured in nanoseconds (billionths of a second!). Second, they can perform operations that are far too complex for human minds. Travel into space would probably have been impossible without them. Third, computers have a vast memory capacity. Even the computers now being bought for home use are able to store many millions of pieces of information. Fourth, computers are unemotional when performing mathematical calculations or analyzing decision alternatives. Computers will not put off making a decision and will not distort facts to build a case. Fifth, computers don't get bored. They find the same challenge in adding two numbers as in guiding an exotic robot.

These strengths of computers suggest the kinds of tasks for which they are most useful: tasks demanding fast completion; very complex jobs, with many tricky computations; and repetitive, boring tasks. The computer, though, is really a fast, efficient simpleton. It can only follow orders spoken in the simplest possible language. At least for now, it lacks any real creativity. The computer also lacks requisite variety. That is, unlike a human, it can respond only in very limited ways to demands from its environment.

THE DEVELOPMENT OF COMPUTERS

While computers as we know them are fairly recent developments, they have a long and interesting history. The computer's "family tree" will be traced in the next three sections.

The Abacus

The earliest "computer" was a counting device called the abacus. The abacus was developed as early as 1000 B.C. by the Greeks and Chinese and is still used by Chinese merchants. It is made up of a series of beads strung on parallel vertical bars in a frame.

Early Calculating Machines

A variety of devices developed over the past 350 years provided I groundwork for the modern computer. These devices include Pascal adding machine, the Leibnitz calculating machine, the Jacquard loom; Babbage's difference machine and analytical engine, and Hollerith's punched card machine.

Pascal's Adding Machine. Blaise Pascal's computational¹ device was a simple adding machine. He used it to come to the rescue of his father, a superintendent of taxes who tried to reorganize the tax structure after an early version of our modern "tax revolts." The machine had a series of wheels, each with teeth representing the digits 0 through 9. When a wheel rotated past 9, the next wheel automatically rotated. When it in turn reached 9, the next rotated, and so on. This simple "tens carrying" feature made the machine very popular.

The Leibnitz Calculating Machine. The Leibnitz machine^{*} based on Pascal's adder, could also perform multiplication and division. Unfortunately, it and other calculating machines of the time were not very reliable. They also required manufacturing capabilities beyond the times.

The Jacquard Loom. One device that had a major impact on the appearance of the computer was the Jacquard loom. The loom, developed around 1800, used punched cards to control the patterns that were woven into cloth. Instructions for a particular pattern could be stored on a set of punched cards, saving weeks of setup time. If a hole appeared on a card inserted in the loom, the loom was instructed to lift a thread. If there was no hole, the thread would be depressed. That one-zero or yes-no system is the basis for the modern computer.

Babbage's Difference Machine and Analytical Engine. Charles Babbage, an eighteenth-century English mathematics professor; is sometimes called the father of early computers. Two devices that he developed over a 60-year period—the difference machine and the analytical engine—provided many of the ideas for modern computers.

The difference machine was designed around 1822 to produce mathematical tables that previously had taken expert mathematicians

years to compute. While it could serve only this single purpose, Babbage saw the possibility of a general-purpose calculating machine. The analytical engine was like modern computers in many ways. It had a memory, an arithmetic device, punched card input, automatic printing of results, and a programmed set of instructions.

Hollerith's Punched Card Machine. Herman Hollerith invented the first practical punched card tabulating machine for the taking of the 1890 U.S. census. Data were stored on cards by the use of punched holes. The cards could be stored after use and could then be used again in the future. Because of the tabulating machine, the 1890 census took only two and one-half years, less than a third of the time previously needed. Many more recent punched card approaches to data processing in business are based on Hollerith's system. The tabulating machine company which Hollerith founded in 1886 later merged with others to become what is now the International Business Machine Corporation [IBM].

The Mark I Computer

The Mark I computer, completed at Harvard University in 1944, was remarkably similar to Babbage's analytical engine. It is considered to be the first digital computer. It could perform a lengthy series of arithmetic and logical operations without any human intervention after start-up. However, since many of its parts were mechanical, it was not nearly as fast as was desired.

MODERN COMPUTERS

Modern computers are electronic. This means that they rely entirely on electronic pulses to function. Early electronic computers used vacuum tubes. Because the vacuum tubes were bulky and generated quite a bit of heat, the computers were often huge and had to be kept in air-conditioned rooms.

The first big electronic computer, ENIAC (Electronic Numerical Integrator and Calculator), was built in 1946. It took up 1,500 square feet of floor space, weighed 30 tons, contained 18,000 vacuum tubes, ate 140,000 watts of electricity, and cost a fortune. It was quickly made obsolete by the development of the transistor. Transistors allowed computers to be smaller, more reliable, and easier to maintain and repair. Computers also became faster, had greater memory capacity, and could use a variety of languages,

Most computers now use integrated circuits, called microprocessors, instead of transistors. **Microprocessors** are tiny wafer-shaped chips

that can hold as many as 128 million pieces of information. A single chip of this type is more powerful than its ancestor, ENIAC. Unimaginable a few decades ago, these chips are now a part of our lives; such everyday products as digital watches, pocket calculators, and video games could not have been built without them. Partly because of such technological developments, computing power is dropping sharply in price.

Computers come in all sizes, including huge "supercomputers." However, microprocessors have made it possible to develop small, yet powerful minicomputers and even the typewriter-sized microcomputers that are finding extensive use in businesses and homes. Complete microcomputer systems capable of performing statistical analyses, text editing, and many other business-related chores are now available for under \$2,000. With minicomputers and microcomputers, firms can engage in distributed data processing in which some computing functions are carried on outside a central location. This may offer benefits of speed and flexibility.

COMPUTER HARDWARE

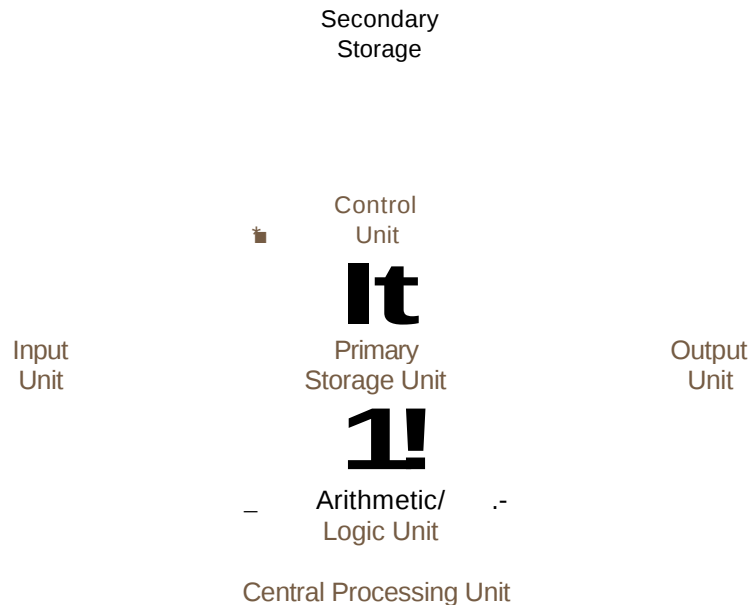
The computer and its support equipment are called hardware. It is the collection of metal, plastic, nuts, and bolts that we see when we look at a computer. As shown in Figure 18-1, the hardware includes input units, processing units, and output units. As a group, input and output units are referred to as peripheral equipment.

Input Units

Data and programs are entered into a computer system through input units. Before this happens, however, the data and programs are in "machine-readable" form on punched cards, paper tape, magnetic tape, disk, or other storage media. Card readers, paper tape readers, and magnetic tape drives are all examples of input units. Generally data are collected for some period of time, such as an hour or a day, and then processed all at the same time. This is called batch processing.

Nearly everyone has seen visual display terminals in offices, airports, or banks. Visual display terminals use a cathode ray tube (CRT) screen much like that of a television—to show input and output. As data and instructions are entered on a typewriter-like keyboard, they appear on the screen. Visual display terminals allow for on-line processing in which input and output units are hooked directly to the processing unit for instant input and output. Such terminals also permit time-sharing, in which many different terminals are hooked to the same main computer.

Figure 18-1 TYPICAL COMPUTER
HARDWARE COMPONENTS



Source: William H. Cunningham, Ramon I. Aldag, and Christopher M. Swift, *Introduction to Business* (Cincinnati: South-Western Publishing Co., 1984), p. 436. Reproduced with permission.

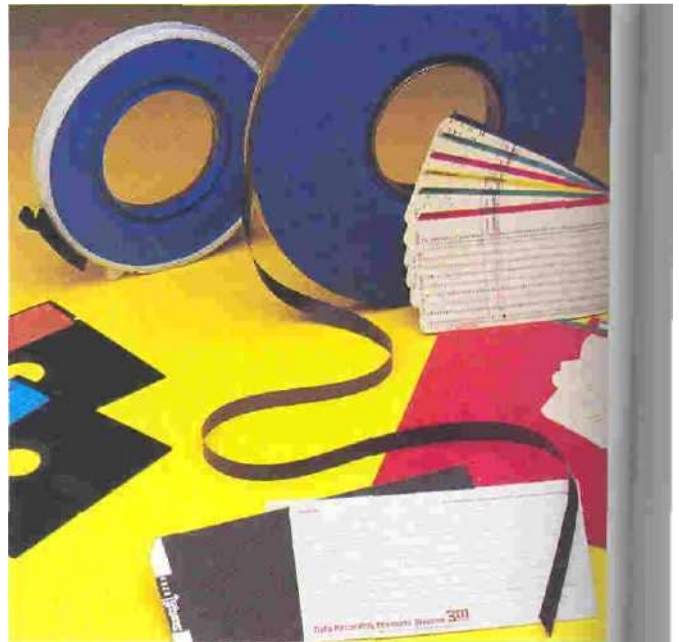
Because the main computer processes data so quickly, each user gets a very rapid response.

HAL, the computer in *2001: A Space Odyssey* and *2010: Odyssey Two*, communicated with two humans by speaking and listening. Some computers now have this voice input capability. One computer has been developed that can even tell the difference between a Texas drawl and a proper English accent. United Parcel Service has a sorting computer that interprets spoken destination codes and then directs a mechanical arm to move packages accordingly. Figure 18-2 shows some input media.

Processing Unit

The **central processing unit (CPU)** is the "brain" of the computer. It does the computer's thinking and memorizing. The CPU has three main parts: the arithmetic/logic unit, the control unit, and the primary

Figure 18-2
Data and
programs are
entered into a
computer
system through
input media.



storage unit. The arithmetic/logic unit performs the mathematical operations [such as adding and subtracting) and logical operations (such as comparison) on the data. The control unit directs what happens within the computer. For instance, it indicates where data should be stored. The primary storage unit is the computer's main memory,, storing data and program instructions.

Output Units

Output units present the results of computer operations to the user. Sometimes results are presented in a form that can be read by the user, such as on a computer printout. Other times, they are put in a form that is easy to store or to use for further operations. Examples include punched cards or magnetic tape.

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Secondary Storage

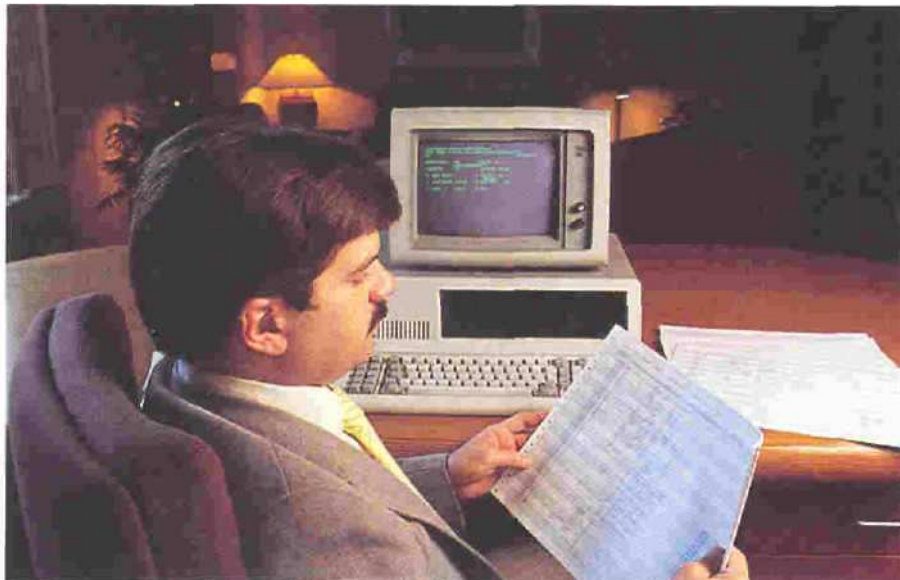
Secondary storage is extra memory outside the primary storage unit of the central processing unit. Magnetic tapes and disks are examples of secondary storage devices.

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COMPUTER SOFTWARE

As shown in Figure 18-3, software refers to computer programs, procedures, and documentation associated with the use of a computer system. Software must be prepared before the computer is used. Without it, hardware is useless. The computer software industry is growing rapidly, with thousands of active companies.¹ Typically, software preparation involves flowcharts, programs, and documentation.

Figure 18-3
Computer
hardware is
useless without
software.



Flowcharts

A program flowchart is a graph showing the sequence of operations to be performed by the computer. Suppose we would like to write a program instructing the computer to figure a weekly paycheck. We might first draw a flowchart such as the one shown in Figure 18-4. Then we would use the flowchart as the basis for writing a computer program.

Computer Programs

A computer program is a precise set of instructions, usually written from the program flowchart. The set of instructions is coded in a

1. "Software: The New Driving Force" and related articles. *Business Week* [February 27, 1984], 74-96.

Academic Profile

ARCHIE B. CARROLL



Archie B. Carroll (Ph.D., Florida State University) is Professor of Management at the University of Georgia. His work on computers in business, social responsibility, and other topics has appeared in over 50 articles in a variety of major journals. He has published eight books, including *OM-puters for Business: A Managerial Emphasis*, revised edition, and *Computers for Business: A Book of Readings*, second edition, both coauthored with Hugh Watson. Professor Carroll has served in many professional capacities in the Academy of Management and the Southern Management Association and has served on the editorial boards of the *Academy of Management Review*, *Journal of Management*, and the University of Georgia Press. He has taught in executive development and management training programs throughout the United States.

Q: It seems that virtually every area of management is now being affected by computers. Do you see this as a continuing trend or a fad?

A: Computers are not a passing fad. They are here to stay. New technologies will displace the old, of course, but computers will become evermore pervasive in organizations. Computers are now touching virtually every function or process today. Q: What do you see as some major consequences of this increasing use of computers in management?

A: One major consequence is in the realm of enhancing human and organizational productivity. Computers will cause a multitude of other management consequences though. Computers change the nature of work and how this work gets done. They change the mix of tasks managers perform, they have added new responsibilities to the manager's workload. Now, managers must have up-to-date knowledge about computers as they plan, organize, and establish monitoring and control systems for the computer resource. These changes in managerial work necessitate changes in how managers are educated. Power shifts in organizations will also result with the computer's introduction. Traditional power bases erode and conflict surfaces as new relationships are established and supplant the old. New positions for information specialists are created and these individuals wield enormous power. Many of the actions they take dictate how managers make their own decisions and what information and range of choices are open. The proliferation of these information specialists does not exempt other managers from knowing about computers. Indeed, it increases the amount they need to know so that they can deal with these people on a competitive level and not lose their prerogatives by default. Q: Do you see any dangers associated with more wide-

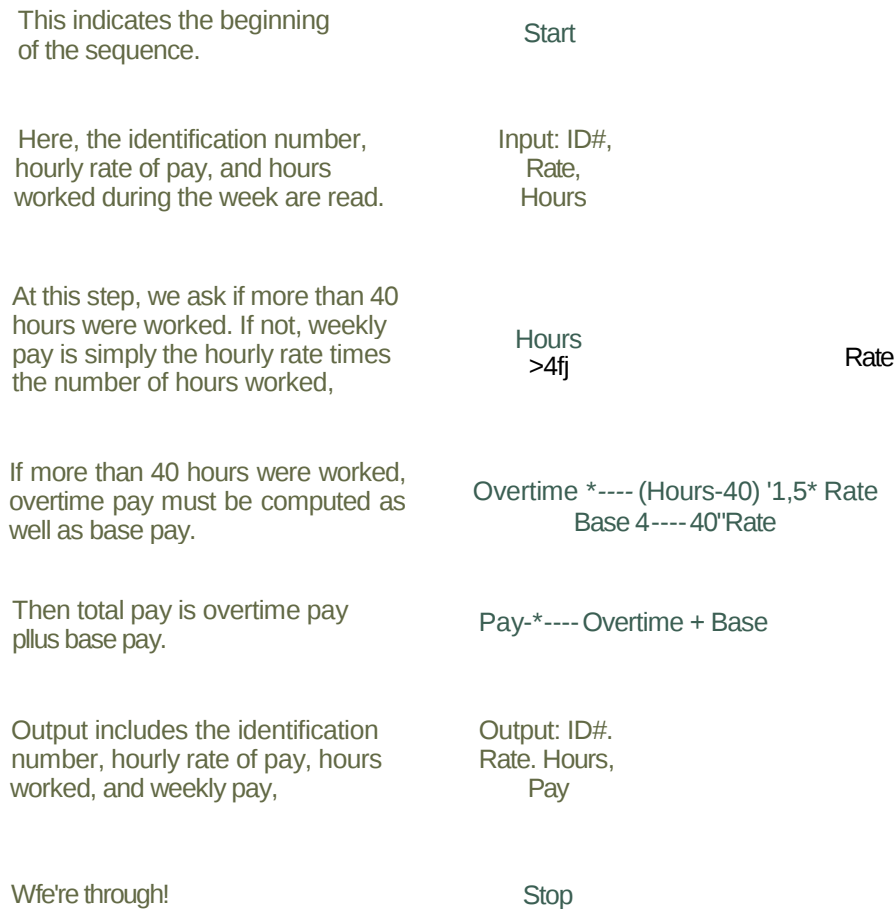
spread use of computers in organizations?

A: Though computers enrich our lives and relieve us from the age-old drudgery of repetitive, unrewarding tasks, there are a number of drawbacks associated with their widespread usage and vigilance. Efforts must continue to help us present human values and dignity as questions such as "Who is in charge here?" are continually asked. One danger is dehumanization. Related to this is the danger that our privacy will be excessively and unfairly invaded. As more and more personal information is kept, questions about the misuse of data and confidentiality will continue to plague us. Governments, banks, hospitals, schools, places of employment, credit card companies, and others all store and maintain huge files on us. So, the fear of (lit) Bit Brother syndrome is real in many people's minds. Privacy protection, therefore, becomes a responsibility managers take on in today's environment. Computer-assisted crime is another serious and increasing danger. Principal threats to organizations have been the use of the computer to steal, or misappropriate, funds or assets, information, and steal computer time. Software against each of these has posed new challenges. The merger of computers and telecommunications (satellite and microwave transmissions) has created more significant ramifications for widespread pilferage of information, N, heretofore existed. Information security has become an important new management responsibility. Questions in the realm of software propriety between employees and employers are increasingly being raised. In these and other ways, computers raise many social, ethical, and practical problems for organizations and place numerous new responsibilities on managers.

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Figure 18-4 A FLOWCHART FOR COMBUXN& WEEKLY PAY



Source: William H. Cunningham, Ramon J. Aldag, and Christopher M. Swift, *Introduction to Business* [Cincinnati: South-Western Publishing Co., 1984], p. 439. Reproduced with permission.

language that the computer can understand. Computers can read any of several languages, none of them, unfortunately, is "simple" English.

Machine Language. Machine language, popular among programmers in the early days of computers and still used by some, is based on the binary system; that is, on only two digits—0 and 1. These digits [called **bits** from Binary digits] are combined into strings (called bytes). Bytes, in turn, are used to represent alphabetical characters. Digital com-

puters operate by turning on and off many electrical circuits. Turning a circuit on represents a "1"; turning a circuit off represents a "0."

Since machine language is hard to learn and use, other "higher level" languages have been developed. These higher level languages are called symbolic languages because they are made up of many symbols such as 4, x, DO, and /. Inside the computer, a language translator called a **compiler** translates symbolic language into machine language so that it can be understood by the computer. Let's take a look at a few of the more popular symbolic programming languages.

BASIC. As its name suggests, the BASIC language [short for Beginners All-purpose Symbolic Instruction Code] is easy to learn. BASIC is the language most often used on small computers. Since small computers have been adopted by many organizations, a knowledge of BASIC is very useful. Figure 18-5 shows what a BASIC program looks like. It is based on the flowchart drawn in Figure 18-4.

COBOL. COBOL [COmmon Business-Oriented Language] was developed so that data could be processed in a language something like English. Despite being rather difficult to learn, COBOL is widely used throughout business.

FORTRAN. FORTRAN (from FORMula TRANslator) was developed by IBM in the 1950s and is still widely used for mathematical and statistical applications. FORTRAN is the most widely taught programming language in colleges of business administration. Although similar to BASIC and somewhat more flexible, it is a bit harder to use.

Canned Programs. Happily, using a computer does not mean starting from scratch and writing a program in BASIC, COBOL, or FORTRAN. Many **canned**, or **packaged, programs** are available. These programs may perform statistical analyses, find optimal solutions to a problem, provide a convenient form for keeping track of records, or perform hundreds of other tasks. Often they are reasonably priced and have already been thoroughly "debugged" to make sure they contain no errors.

Documentation

Documentation refers to the process of providing a permanent record of a computer program. Good documentation makes it easier to find flaws in programs. It is crucial to new users of a previously written program. Generally documentation indicates why the program was written and includes the program flowchart, the program, sample input and output, and comments.

Figure 18-5 **A BASIC PROGRAM TO COMPUTE WEEKLY PAY**

These statement numbers tell
the computer the order in which
the statements are to be executed.



This statement serves as a reminder of the
purpose of the program.

Identification number, hourly rate of pay,,
and hours worked are read.

10 REM PROGRAM TO COMPUTE WEEKLY PAY

20 READ ID,R,H

if-then statement allows branching.
If hours worked are greater than 40, it
branches to statement 60. If not, it
reaves on to the next statement.

30 IF H>40.& THEN GOTO 60

If .pp. more than 40 hours were worked, _
if this statement computes pay.

This statement tells the program to go to
statement 90. (Otherwise, pay would
be computed again.)

50 GO TO 90

Here, overtime pay is computed. [Notice
that we get to this point only if more
than 40 hours were worked.)

Base pay for 40 hours is figured here.

70 B=40*R

Total pay is overtime pay plus base pay.

80 P=OV+B

This statement prints out the
identification number, hourly rate of
pay, hours worked, and pay.

90 PRINT ID,R,H,P

The end.

100 END

Source: William H. Cunningham, Ramon J. Aldag, and Christopher M. Swift, *Introduction to Business*
Management (South-Western Publishing Co., 1984), p. 440. Reproduced with permission.

COMPUTER APPLICATIONS IN MANAGEMENT

We have touched on computer applications in management throughout this text, and we will continue to do so. For instance, we have seen how computers are transforming communications, how they are used in training, and how they permit automated decision conferencing. In coming chapters we will discuss their roles in robotics, in management

information systems, and in a wide variety of operations management applications. Here are some additional uses.

Job Design Applications

Computers are permitting some fundamental changes in the way that jobs and organizations are designed. For instance, a supervisor who once would have walked around the plant to check on employees' performance can now stand over a computer screen. In general, people are talking more with machines and less with other people, and work becomes more abstract. Further, jobs that were once quite different now are becoming more similar, with bank auditors and pulp-mill operators sitting in front of identical computer screens and monitoring on-line information.²

In addition, with the advent of small home computers that can communicate with remote office locations, the electronic cottage has become a reality. The electronic cottage is the name given to stay-at-home computer work. Employees can carry out their tasks on their home computers and then transfer the results to the office without ever leaving their homes. The electronic cottage provides employment opportunities for the disabled, homebound parents, and others who historically would have been unable to get to work on a regular basis.

Staffing Applications

Computers have many applications in staffing, including training, keeping track of information on job applicants, developing selection tests, and storing a wide variety of information on personnel.*

Computers can now train employees more rapidly, more economically, and even more enjoyably than through conventional means. Unlike¹ early computer training in which the computer was basically a book on a TV screen, new systems are more fully interactive and able to react to the student. Computers are now used to train mechanics at Ford dealerships, to teach inventory control techniques at J.C. Penney, and to train IBM repairpersons.⁴

1. These examples are drawn from J. Main, "Work Won't Be the Same Again," *Fortune* (June 28, 1982), 58-65. For an overview of computer applications in business, see H. I. Watson and A. B. Carroll, *Computers for Business*, 7th ed. (Dallas: Business Publications, Inc., 1980).

3. See, for instance, T. S. Darany, "Computer Applications to Personnel: The Genie—Harnessing the Dragon," *Public Personnel Management Journal* (Winter 1983) 451-73.

4. J. Main, "New Ways to Teach Workers What's New," *Fortune* (October 1983), 181-85, 86, 90, 92, 94. See also H. L. Schuette, "Educating Executives: Computers I Factory into the Classroom," *Management Review* [March 1984], 15-21; and S. Schwade, "It Time to Consider Computer-Based Training?" *Personnel Administrator* (February 1984) 25-35.

Application of computers to the management of employee careers, particularly to decisions concerning promotions, is described in Case 18. Such applications are especially important in dynamic situations and in those in which affirmative action pressures are great.

Decision-Making Applications

Computers are now heavily relied on to improve decision making. Many of these decision-making applications, including expert systems and decision support systems, will be discussed in the next chapter. An additional intriguing application is for modeling of decision makers. People in organizations occasionally face the same routine decisions day after day. An admissions officer selecting people for a college program, a bank officer deciding whether to approve a loan, or an operations manager considering schedules for daily production runs are all examples. These decisions are important, and while the decision makers may feel considerable responsibility for them, they are time consuming and repetitive.

Individuals facing such decisions would probably welcome someone (or something) that would make the decisions for them and do so just as the individuals would have made them. This can be done by building a **model of man**, that is, by designing a computer model of the decision maker. Once the model is constructed and tested for accuracy, it can replace the decision maker. In borderline cases, the model could leave the decision up to the manager.

Such models have some useful, and perhaps surprising, benefits. Along with freeing the decision maker's time, they may provide insight. That is, a model may reveal how information was weighted or combined [facts of which the decision maker was unaware). Such a model can also serve as a valuable training tool for novices by showing how experienced decision makers use information. Finally, the model may actually work *better* than the decision maker it replaces. Because it doesn't get fatigued and has no mood swings or mental lapses, the model is perfectly reliable. This increased reliability improves validity.⁵

Control Applications

While some computer applications, such as the electronic cottage, offer workers additional autonomy and responsibility, computers may also be used to increase management control. Worker performance can be

a. For discussions of models of man, see L. R. Goldberg, "Man versus Models of Man: A Rationale, Plus Some Evidence, for a Method of Improving on Clinical Inferences," *Psychological Bulletin* 73 (1970), 422-32; and I. Zisamer, "A Comparison of the Prediction Accuracy of Loan Officers and Their Linear-Additive Models," *Organizational Behavior and Human Performance* 27 (1978) 69-74.

constantly monitored and related to goals and norms. At Fleming Companies, a food wholesaler, workers insert cards in computer terminals when they begin work. The computer tells them how long management thinks a job should take. When they complete their jobs, workers again insert their cards. If they beat the clock, the screen flashes, "Good job." If not, the computer indicates how far below capacity performance is.⁶ Further control applications are discussed in Situation 1.

SITUATION 1

Productivity Spies

Vaughn Foster has U.S. 85 all to himself as he swings his truck onto the highway for his last trip of the day. To his right, the sun is disappearing behind the Rockies; ahead, the road stretches straight and empty for miles. I eye on the speedometer, he eases into the right lane and starts cree ahead at 50 miles an hour.

"I've been out all week," he says. "My wife's home, my kids are home¹ and I'd just as soon be there with them. There's no doubt about it: computer wasn't there. I'd be running 60 easy."

Mr. Foster is talking about a black box the size of a dictionary that sits in a compartment above his right front tire. At the end of his trip, his boss at Leprino Foods Co. in Denver will pull a cartridge out of the box and pop it into a personal computer. In seconds the computer will print out a report showing all the times the truck was speeding.

Computers are transforming thousands of jobs at companies like Leprino in a significant new way; They are watching over employees and monitoring their productivity.

Typists in word-processing pools generate reports that show how many pages they produce in a day and how many keystrokes they produce in 5 minutes. Supervisors of telephone operators scan summaries of how many calls each operator answers and how long each call takes. In production plants making everything from spark plugs to Tupperware, supervisors glance at terminals and see instantly which machine operators are ahead of schedule and which are behind.

To many managers, computer monitoring has brought wondrous results. They say it motivates employees to meet company standards and makes them more productive workers. Some managers also find that computer printout provides an objective way to rate a worker's performance and determine raises and promotions without giving scapegoats or pets special treatment. And at least one employer has used monitoring technology to ferret out an episode of apparent office sabotage and build a case against a suspect.

But as electronic watchdogs move into the workplace, they are stirring alarm among a growing number of unions, government officials, and labor

6. Fleming's fast Rise in Wholesale Foods," *Fortune* (January 21, 1985), 54.

experts. These people worry that the practice breeds stress and dehumanizes employees. In 1985, seven states considered legislation to restrict the practice. Twenty unions have adopted official positions against monitoring, and one, representing claims processors at Equitable Assurance Society, has succeeded in fashioning a contract that it credits with establishing limits.

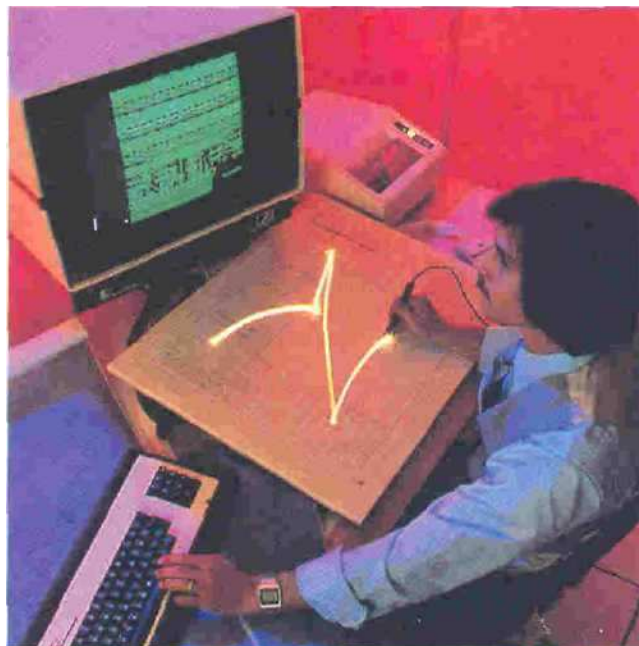
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Operations Management Applications

Computers now design products, run production lines, check product quality, control machine loads, and guide machines automatically. As we will discuss in Chapter 20, computers are essential to material requirements planning. Two additional manufacturing applications are computer-assisted design and computer-controlled production.

Computer-Assisted Design. To produce many of the special effects of the science fiction movie, "TRON," the dimensions of real objects were fed into a computer. The computer then displayed on a screen an image of each object from any distance and from any perspective. Figure 18-6 shows an example of this procedure. These processes are

Figure 18-6
Computers have
become
instrumental in
rapid completion
of design
projects.



what computer-assisted design (CAD) is all about. CAD is a popular tool used by auto makers and architectural firms for speeding up design projects and reducing the number of needed drafters. It has been used in the volatile sportswear industry—in which product lines may change five times a year—to help deal with fashion obsolescence.⁷

Computer-Controlled Production. Many businesses use computers to run and control manufacturing processes. For example, numerical control is a system that relies on punched tape or some other automatic control mechanism to direct machine operations. Lathes, looms, and riveting machines are often run by numerical control. Computers have been used extensively in chemical production, oil refining, and other industries that involve large-volume processing. Computers also put a layer of Jvt only a few ten-thousandths of an inch thick on Polaroid film.

Data Processing Operations

Another important application for computers is that of data processing. Data processing is another term for information handling. The information could be of many types, such as names of customers, prices of products, economic indicators, or units of inventory. Data processing may involve such operations on data as computation, classifying, merging, and moving and editing.

Word Processing Applications

Microcomputers are increasingly used for word processing. With a word processing system, a person can input, output, and store information in one easy operation. Corrections can be made easily, words or sections can be inserted, deleted, or shifted around. In the next section we will consider microcomputers in more detail.

MICROCOMPUTERS

Microcomputers, sometimes called **personal** computers, or PCs have made remarkably fast inroads into the business world. They are becoming powerful enough to handle most applications, yet are falling in price. IBM's revenues from sales of microcomputers jumped from \$2.6 billion in 1983 to \$4 billion in 1984, while those of Apple Computer Inc

7. K. H. Shaffir, "Information Technology for the Manufacturer," *Management Review* [November 1985], 61-62.

FROM THE FIELD: Microcomputers in Organizations

In early 1986, we surveyed executives in a variety of industries to learn more about the use of microcomputers in organizations. We asked, "How would you characterize the degree of use of microcomputers in your firm?" On a scale of 1 to 5, with possible responses including 1 (declining rapidly), 3 (neither growing nor declining), and 5 (growing rapidly), the average response was 4.1. The controller of a food-processing firm commented, "Education in the function and use of microcomputers will be an absolute necessity to succeed in the future business world."

The most common applications of the microcomputer were reported to be financial analysis (100%), word processing (85%), statistical analyses (85%), budgeting (85%), and accessing the mainframe computer (80%).

We asked, "What do you see as the major benefits to your firm of the use of microcomputers?" Ranked in decreasing order, the responses were improved efficiency (86%), enhanced flexibility (79%), time savings (71%), improved information access (64%), and cost savings (50%).

To the question, "What do you feel are the chief barriers to the use of microcomputers in your firm?", the five most commonly reported were as follows:

Rank	Barrier	Percent Reporting
1	Cost considerations	50.
2	Concerns about confidentiality of information	43:
3	Lack of availability of necessary software	28
4	Resistance on the part of management	
5	Lack of applicability to specific needs of the firm	14

Interestingly, employee resistance, possible malfunctions, and concerns about technological obsolescence were rarely cited as barriers. The vice-president for computers and information systems of an aerospace manufacturing firm added, "Micros have proven to be of great value. However, they do raise questions of management control with respect to software configurational control, data accuracy, data integrity, data security, and data element definition."

It is evident that executives see microcomputers as useful and that applications are growing. Executives do feel, though, that microcomputers present new challenges for management.

rose from \$1.1 billion to \$1.9 billion over the same period.⁸ Despite concerns about a possible slowdown in the industry, it was estimated that the microcomputer market would show a 20 percent growth rate from 1985 to 1986.⁹

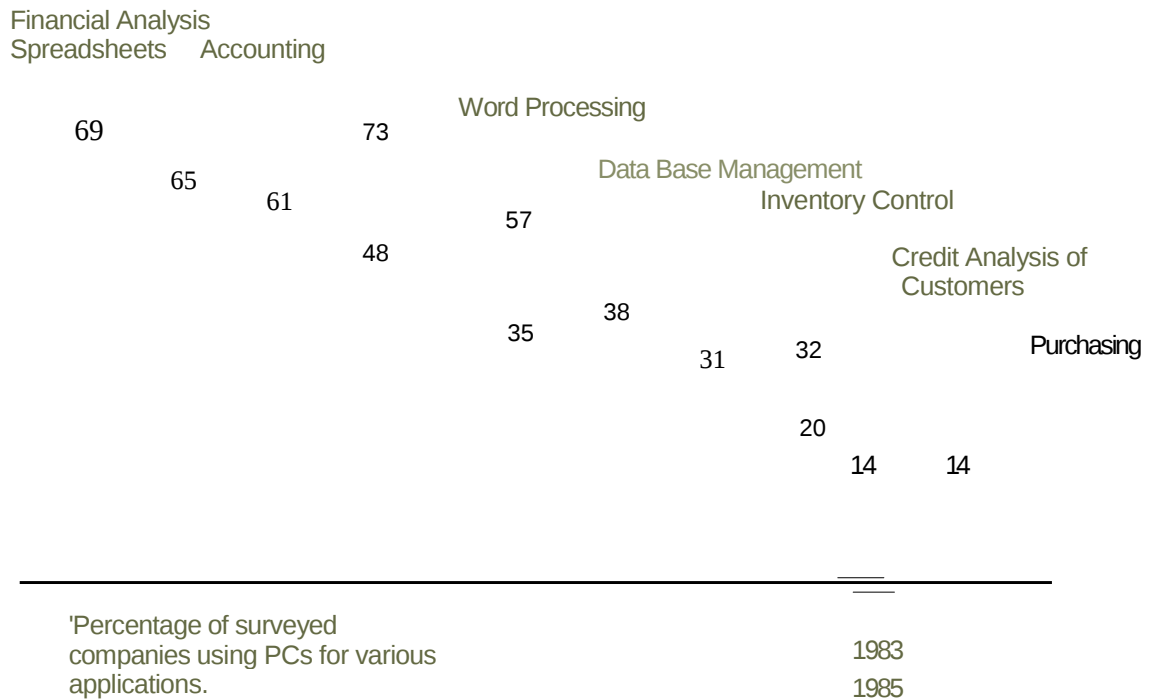
8. *Datamation* [June 1, 1985], 38.

9. P. R. Strauss, "Fast-Paced and Growing: Industry's 15 Percent Surge May Surprise Many!" *Data Communications* [January 1986], 72-73.

Microcomputer Applications

Figure 18-7 shows PC applications in 1983 and 1985. The predominant applications are shown to be for accounting, financial analysis, word processing, and data base management. Purchasing applications are shown to be growing rapidly.

Figure 18-7 **PC APPLICATIONS'**

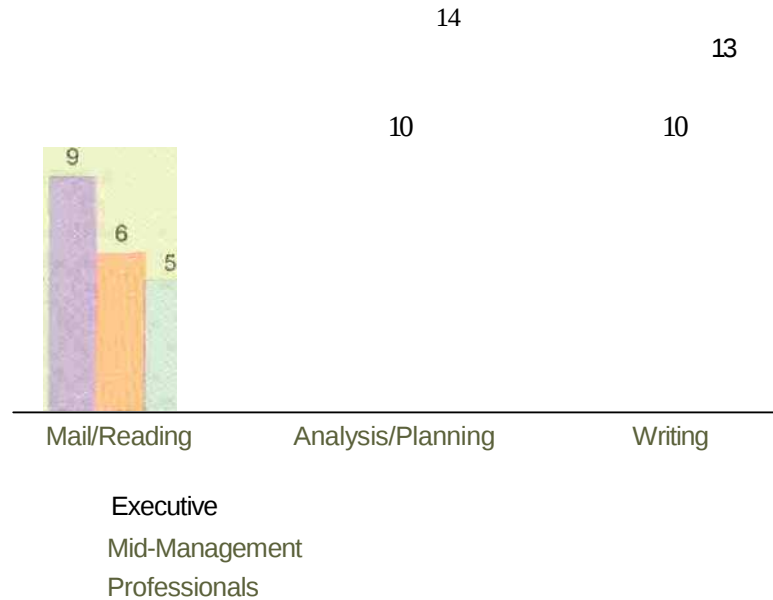


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As shown in Figure 18-8, the amount and nature of use of PCs varies by level in the organization. The heaviest use of PCs by executives, is for accessing electronic mail and other information. At other levels PCs are used more for planning and analysis and for writing.

As we will discuss in the next chapter, microcomputers give managers the ability to access a tremendous amount of information by simply i

Figure 18-8 PERCENTAGE OF WORKDAY DEVOTED TO PC USE BY OCCUPATION LEVEL



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using "knowledge-based" programs. These programs contain rules and "how-to" tips, as illustrated by Situation 2.

SITUATION 2

Management Software to Get the Boss Involved

New software has surfaced that takes a shot at overcoming managerial reluctance to step personally into the computer age. Many of these programs are "knowledge-based"—so-called because they permit an executive to tap into compendiums of rules and suggestions for how to handle specific situations, much in the way that some of the popular "how-to" books might do. They deal with negotiating skills, training, strategic planning, and other areas that managers cannot delegate. And they have been written for desktop computers. "These programs get at the essence of what a manager does," says Jack B. Levine, president of Thoughtware Inc., a new company in Coconut Grove, Florida, that offers 14 managerial programs. "The benefits are not ephemeral. They are real, and they should give people the motivation to use

them." Mr. Levine maintains that many of the programs can obviate the need for off-site management training programs or outside consultants, and that once businesspeople discover this, the market for all types of managerial software will explode to \$1 billion annually.

Human Edge Software has five programs that sell for between \$50 and \$295 each and draw extensively from published literature in psychology dealing with the relationships of managers and their staffs, sales representatives and customers, and people engaged in negotiations.

For example, someone using Human Edge's Negotiating Edge program would be asked to agree or disagree with more than 50 statements. A few samples; "Fair play is a losing strategy," "I would rather travel than have a desk job," and "Others on the job count on me to stir up some action."

Next, the user describes the person with whom he or she is about to negotiate. To do this, the user agrees or disagrees with each of more than 40 adjectives such as *manipulative*, *empathetic*, *precise* and *double-dealing*.

Lastly, there are a few questions about the circumstances of the meeting, such as whether others will be present, how much time will be available, and whether the two main players will ever bargain with each other again.

After the data are entered, the program generates a 2,500-word character analysis of the person with whom the manager will negotiate and suggests ways in which the user can get the best of the meeting.

Source: Abridged and adapted from Thomas C. Hayes. "Management Software to Get the Boss Involved," *The New York Times* (December 2, 1984). SF. Copyright © 1984 by The New York Times Company. Reprinted by permission.

Microcomputer Communications

While microcomputers are themselves becoming very powerful, their power and promise multiply when they are able to communicate among themselves and with mainframe computers. Such communication is possible through the use of modems and networking.

Modems. A **modem** (short for modulator-demodulator) is a device that permits computers to communicate by way of telephone lines. With a modem, one microcomputer user can phone another and transfer financial data, or other information. A user can also call a mainframe computer, carry out computations on the mainframe via a keyboard, and output the information through the microcomputer. Further, modems let microcomputer users access electronic bulletin boards. These **electronic bulletin boards** provide microcomputer users a wide array of information. After the modem is used to call the board, messages can be read from the bulletin board or added to it. Electronic bulletin boards are now available containing financial information, job opportunities, newspapers and magazines, airline schedules and prices,

the status of pending legislation, weather data, and almost anything else imaginable.¹⁰ Unfortunately, we will see later that the boards are sometimes misused.

Networking New developments in technology which link previously incompatible computers are making large-scale networking of computers more feasible. Such networking ties computers together, permitting them to communicate without modems and to access tremendous amounts of information. For instance, local-area networks are being used to turn Travelers Corp. into "one big switch," moving around financial data and linking 3,000 databases and thousands of computers in several hundred offices. The company has spent \$10 million laying two million feet of cable in its new Manhattan headquarters building so it can ultimately link computers for 8,000 employees. Joseph Brophy, a senior vice-president at Travelers, envisions the day in the 1990s when 400,000 machines, including 30,000 home computers, will be linked to 60 data and claims centers and 300 field offices, allowing one-stop shopping at the computer screen for auto, health, and life insurance.¹¹

PROBLEMS WITH COMPUTERS

We began this chapter with *Time* magazine's choice of the computer as the "greatest influence for good or evil." We have considered many of the potential benefits of computers. Now, let's take a look at problems sometimes associated with computers.

Malfunctions

AH of us have heard about computer malfunctions. A computer error caused false alarms on the Air Force's NORAD missile detection system, moving us to the brink of war. On a smaller scale, computer malfunctions can be devastating for businesses. The increasingly heavy reliance of firms on computers creates a situation of dependence. For instance, business organizations were surveyed to learn how long they would be able to operate without the information-processing capabilities of computers. Many firms reported that they would quickly be immobilized by a major computer failure. After five and one-half days without a

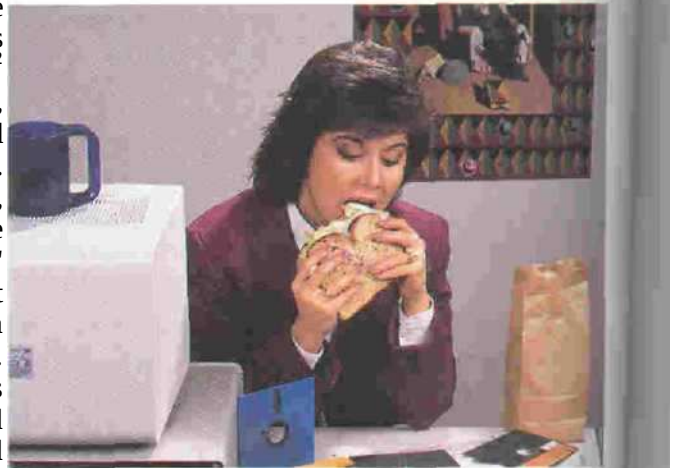
10. D. Seligman, "Life Will Be Different When We're All on Line," *Fortune* [February 4, 1985], 68-72.

11. D. Kneale, "Computer Caution: Linking of Office PCs Is Coming, but Plenty of Obstacles Remain," *The Wall Street Journal* (January 28, 1986), 1, 20.

computer, only 28 percent of operational activities would be functioning.' Among finance firms that responded, it was estimated that only 13 percent of operations would be functioning after five and one-half days without computing.¹²

Often, though, computers are blamed for human mistakes. By simply saying, "We had some computer problems," it is easy to shift responsibility to a guileless computer. Such a statement is typically greeted with a resigned nod and the unspoken understanding that "These machines aren't as smart as they think they are."

Computer mishaps may occur through misuse or abuse.



Errors in Use

Unfortunately, many people operating computers are not being properly trained in their use. Further, users may fail to do routine checks for errors. As one example, there is concern that users of the very popular electronic spreadsheet programs, such as Visicalc and Lotus 1-2-3, may fail to carry out simple checks on the accuracy of their results. One California executive used an electronic spreadsheet on his personal computer to predict that a computer his company planned to introduce would reap \$55 million in sales in its first two years. Based on that projection, other managers began making aggressive plans to add staff and inventory. Unfortunately, the executive had failed to include in the program a price discount planned for one key component, thus inflating the sales estimate by \$8 million. Had the mistake not been caught, it would have...

12. D. O. Aasgaard et al., "An Evaluation of Data Processing 'Machine Room' and Selected Recovery Strategies," University of Minnesota, Management Information Systems Research Center WP-79-04, p. 70.

the new company profits, momentum, and investor confidence.¹³ Managers who routinely check and recheck their own manual computations and logic may fail to do so when using a computer.

Invasion of Privacy

In 1984, George Orwell portrayed computers as all-seeing intruders into people's private lives. Our government now has billions of records on individuals, stored on thousands of data systems. Personal finances, health, travels abroad, and traffic violations are among the data that are available from government computers. Because of fears that such systems could be misused, plans to develop even larger networks of computers, such as a massive network called FEDNET tying together all government computers, have been scrapped.

Businesses also have vast quantities of sensitive information. Medical records, past arrest records, or military discharge information could prove harmful to employees if made public. In response to such concerns, firms are spending huge sums on complex access systems and other forms of security. For instance, Metropolitan Life Insurance Company spends from 2 to 3 percent of its annual data processing budget on security precautions and has a staff of six full-time employees guarding its data.¹⁴ Some firms, such as Cummins Engine Company, have refused to computerize their personnel records. Others, including IBM, have removed much information from their files to guard employee privacy. General Electric, Eastman Kodak, and Caterpillar Tractor allow employees access to their files.

L

Hackers

Hackers—computer buffs who illegally gain access to, and sometimes tamper with, computer files—are becoming a growing threat to businesses. Some see hackers as fun-loving pranksters, others as angry rebels, and still others as wanton criminals. While some hackers' actions, such as interrupting another computer user's work and flashing "Gimme Cookie!" on the screen, may seem harmless, others are very costly to organizations.

Computer Crime

A 25-year-old computer terminal operator used computer trickery to receive pension checks under 30 different names. An accountant work-

13. "How Personal Computers Can Trip Up Executives," *Business Week* (September 24, 1984), 94,

14. "Computer Security: What Can Be Done?" *Business Week* (September 26, 1983), 125-

ing for a fruit wholesaler used a computer to inflate prices on invoices and to send the extra money to dummy vendors. He amassed \$1 million over six years. In the infamous Equity Funding fraud, computers were used to build a confusing pyramid of fake assets. By the time the fraud was uncovered, \$185 million in fake assets had been created.

Computers have spawned a whole new class of criminals. Often computer experts, these criminals take advantage of flaws in systems or of access to files to steal an estimated \$300 million a year. The FBI figures that, while the average armed bank robbery nets about \$10,000, computer crimes often bring in more than \$1 million.

Robert H. Courtney, a security consultant and former director of data security and privacy for International Business Machine Corp., says the likelihood of prosecution is inversely proportional to the amount of money involved. "The bigger the theft, the greater the embarrassment to the company," he says. One of his clients, an insurance company, lost \$38.1 million to a crooked senior officer and didn't report the crime police.¹⁵

Terminal Tedium

Some people see computers as the new assembly lines. People who¹ Once interacted with one another and carried out at least some physical activities now may sit and stare at video displays for eight or more hours a day. There is concern that such "terminal tedium" may be stressful, and even that there may be health hazards associated with constant exposure to the displays. While most claims of health hazards are currently speculative, fears about the consequences of stress and social isolation are harder to dismiss.

Negative Human Reactions

People's reactions to computers run to extremes. Some view the as all knowing. They treat anything coming out of a computer as "not beyond challenge. In fact, of course, what the computer produces is no better than what is put into it and how the computer is instructed to process it. This "garbage in—garbage out" idea is too often forgotten.,

Other people fear the computer, believing that it will threaten their jobs, either by replacing them or by requiring skills that they don't have. Others are concerned that they will become too dependent on computers. For still others, the computer represents change and unknown. Each of these sources of fear may lead to resistance, and it should be seriously considered.

15. E. Larson, "Crook's Tool: Computers Turn Out to Be Valuable Aid in Crime," *The Wall Street Journal* (January 14, 1985) 1, 10.

To some extent, computers are becoming more "user friendly." In his science-fantasy story, "I Sing the Body Electric," Ray Bradbury wrote of an "electric grandmother," a computerized robot designed to look, talk, and act like a warm, supportive grandmother. Computers are rapidly becoming more "grandmotherly."

IMPLICATIONS FOR MANAGEMENT

Computers are becoming pervasive in organizations, and there seems to be no end to their potential applications. They are involved in all stages of the management process, and as a manager you will have to be prepared to use and deal with them.

An increasing number of jobs in organizations will be intimately tied to computer use. If you find yourself in such a position, it will obviously be critical that you master computer skills. Since your future career moves are to some degree uncertain, anticipate such needs.

Further, with the growth in use of microcomputers, you are likely to find yourself using computers on a regular basis as an integral part of almost any job, much like you would use a typewriter or file cabinet. You may turn to a computer to write a memo, check the latest quote on oil prices, design an object, sort customer lists, or make a decision. Basic computer literacy will become a selection criterion for many positions, even those seemingly far removed from information management. Actively seek out opportunities to become acquainted and comfortable with microcomputers.

Whether or not you personally use computers, you and your job will be influenced by them. You may be selected by a computer, trained by a computer, and monitored by a computer. Your boss may turn to a computer to decide how to supervise and reward you, and may use a computer to plot your career moves. Computers may influence the amount of authority you are given and may dictate with whom—if anyone—you directly interact. Computers will permeate the fabric of organizations.

The presence of computers will cause managers to face some difficult questions. Should computers be used as control devices? Who should have access to their information? What steps should be taken to prevent abuse and unauthorized access? What can or should be done to counteract the depersonalizing influences of computers? Should decisions be turned over to computers? You will find yourself facing these and other questions on a regular basis. Give serious thought to the issues raised in this chapter, paying particular attention to concerns noted in the situations and cases. Be prepared to respond to these emerging issues.

Remember that computers are tools, not crutches. They will not transform bad inputs into good outputs. They will not make a dull idea

creative, They will not accept the ultimate responsibility for bad decisions. Try to take advantage of the benefits of computers, but don't be lulled into complacency.

KEY TERMS AND CONCEPTS

analog computer	input units
BASIC	machine language
batch processing	microcomputers
bits	microprocessors
bytes	minicomputers
canned or packaged programs	model of man
central processing unit (CPU)	modem
COBOL	networking
compiler	numerical control
computer	on-line processing
computer program	output units
data processing	peripheral equipment
digital computer	personal computers or PCs
documentation	program flowchart
electronic bulletin boards	secondary storage
electronic cottage	software
FORTRAN	storage media
hackers	time-sharing
hardware	word processing system

REVIEW QUESTIONS

1. What is a computer? How does an analog computer differ from a digital computer?
2. Give five advantages of computers relative to human decision makers. Give three relative disadvantages.
3. What is a microprocessor? Why is it important?
4. List three types of computer input units, three types of output units, and the three main parts of the central processing unit.
5. What is the difference between hardware and software?
6. List four computer languages.
7. Give applications of computers in staffing, operations management, and control.
8. What is a microcomputer? a modem? a network?
9. Indicate three ways in which computers influence the design of organizations and jobs.
10. Discuss five problems that may occur with use of computers.

CASE 18 A Computerizing the Fast Track

The career paths of a growing number of corporate managers are now being charted on

computers. With the advent of software designed to monitor executive talent, per

sonnel specialists are using computers to plan successions, regulate affirmative-action programs, and watch out for junior managers on their way up. Human-resources consultants say that, just as electronic spreadsheets improved financial planning by making complex projections easy to do, computerized executive-tracking systems are improving personnel planning.

Canipaters increase objectivity and allow for a wider scope when considering candidates for promotion, personnel managers claim, thus loosening the ties of the old-boy networks that govern movement within many companies. And, by uncovering inside talent, they lessen dependence on headhunters and can reduce the cost and disruption of outside hiring.

For example, Southland Corp., the Dallas-based parent of the 7-Eleven convenience-store chain, has computerized its search for fast-trackers. Twice yearly, Southland managers file reports about the promotability of their subordinates. By consolidating the reports on a computer, "We find out whether there will be a deficit of people coming up through the ranks," says Blake Frank, Southland's manager of personnel research. A separate program helps produce career-development plans, pinpointing weaknesses and suggesting solutions—university courses, in-house training, a different job, or a special assignment.

Many personnel departments, for these applications and others, are writing their own executive-management programs or snapping up the half-dozen sold by independent companies. Frank Gains, a Greenwich, Connecticut, consultant who ran Exxon Corp.'s executive development program for 15 years, says, "It's like playing chess; you're trying to optimize every vacancy. *With the computer, you can play the game and consider more alternatives.*"

Fast-growing companies often need computerized tracking systems to find scarce talent. But mature companies need them to discover good people who might be stalled. Similarly, affirmative-action software makes it easy to locate areas in which there are few women and minorities and then find qualified people who might be overlooked in informal brainstorming sessions.

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1. Which of the strengths of computers do programs such as these incorporate?
2. What are the benefits of computer programs for career planning purposes? The costs and dangers?
3. Would you like your career to be charted by a computer? Why or why not?

