

► The results of an intensive research program in behalf of over 80 of the largest U.S. and European businesses.

What's Ahead in Information Technology

By John Diebold

One of the major changes American business has lived through in the past few years has been the "computer revolution." But what we have seen thus far is only the beginning. We are on the threshold of an "information revolution" that will affect the practice of management in ways which our conventional notions of computers can only hint at. All the evidence I know of indicates:

■ *The way management manages* will be significantly affected by new capabilities at its disposal and new approaches to management that these capabilities permit.

■ *What management manages* will be profoundly affected in terms of organization structure, makeup of the company work force, and physical facilities. The introduction of the assembly-line concept into American business may not have changed the daily round of appointments of a chief executive, or even the way in which he made his decisions, but certainly it had an impact on the makeup of his company. The changes permitted by the information revolution will be at least as significant.

■ *The external environment* in which the manager manages will place new demands on the enterprise and offer new opportunities for it. The benefits of the information revolution are available to government, unions, customers, suppliers, competitors; and many are pursuing the gains vigorously.

The ideas in this article are based on findings emerging from an intensive research program, currently in its third year, which is being con-

ducted by The Diebold Group, Inc., in behalf of more than 80 of the largest U.S. and European businesses. Included in this number are such companies on the user side as Shell, Gulf, Sun, Standard Oil of California, John Hancock, Jewel Tea, International Paper, Southern Pacific, Monsanto, Glidden, General Foods, Firestone, Goodrich, Du Pont, Boeing, Douglas, and McDonnell Aircraft; and such companies on the equipment-supply side as IBM, UNIVAC, National Cash Register, International Telephone and Telegraph, General Telephone & Electronics, 3 M Company, Texas Instruments, and Xerox. These companies represent a true cross section of modern business. Thus, the research program concerns itself both with common problems and with "special" situations in the complex area of information technology.

Trends in Spending

Cost is one reason for top management interest in the information revolution. Our research findings indicate that by 1970 the U.S. market for information systems equipment will exceed \$7 billion per year, up from about \$1.5 billion in 1961. Based on similar years' estimates of total business investment in plant and equipment, the percentage of the plant and equipment investment that is spent on information systems will go from 4% in 1961 to 13% in 1970, a sizable item in the capital planning for any business.

More important from the top executive's standpoint is the likelihood that there will be

startling and all-pervasive improvements in the character and performance of information systems equipment and processes. We anticipate a seven-to-one improvement between now and 1973, taking into account technical developments in speed, accuracy, flexibility, and capacity.

Some specific company systems forecasts have been made by The Diebold Group utilizing the cost and performance factors developed in our research program. For example, a company that today has equipment valued at \$3,750,000 will by 1973 have equipment costing \$8,400,000, assuming no increase in volume of data processing activity. However, if that company were satisfied to be doing the same data processing tasks, also with no increase in volume, equipment with a value of only \$1,125,000 could do the job in 1973. In fact, this lesser value of equipment, because of anticipated improvements in the nonequipment aspects of an information system, should be able to handle more than twice the workload of today's equipment.

This presents a paradox — increased expenditures in an activity of marked cost and performance improvement. But such a paradox is not a novelty for American business. Here it means that the impact of information systems throughout the organization will be greatly expanded; there will be more effective performance of existing functions, new functions will be undertaken, and different kinds of processing will be emphasized (see EXHIBIT 1). The basis for this parallel development is a series of important

technological and systems advances that will change importantly the makeup of the corporate information system. These are considered in the next section.

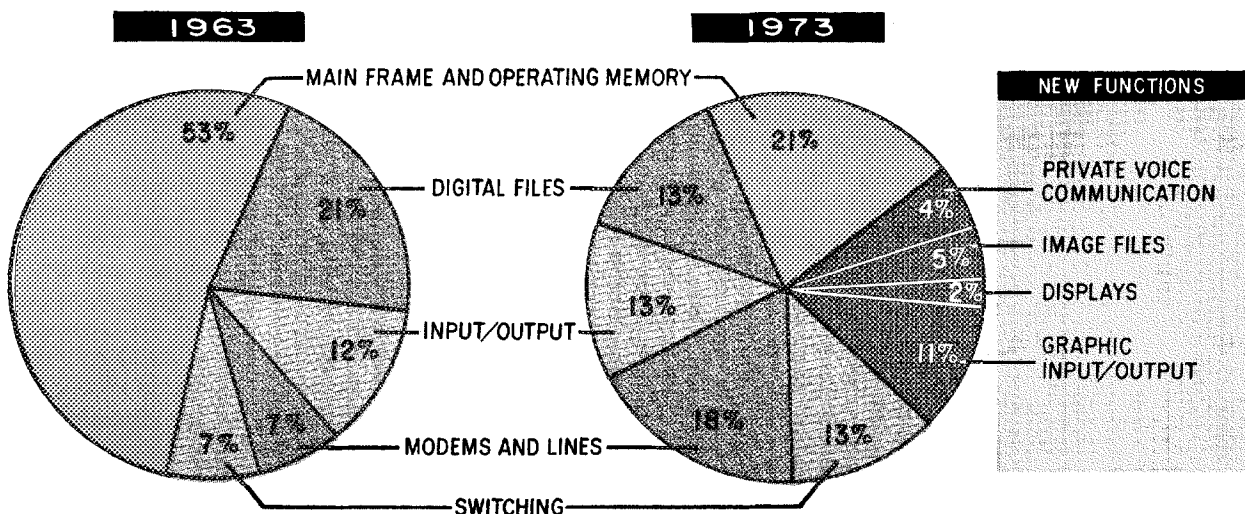
Management & Planning

For executives interested in policy making, seven developments serve to illustrate the importance of what is happening and the diverse management and planning problems that are inherent in such developments. I shall describe each one briefly.

1. *Future information systems will be more versatile and will more nearly parallel the real flow of information within an organization.*

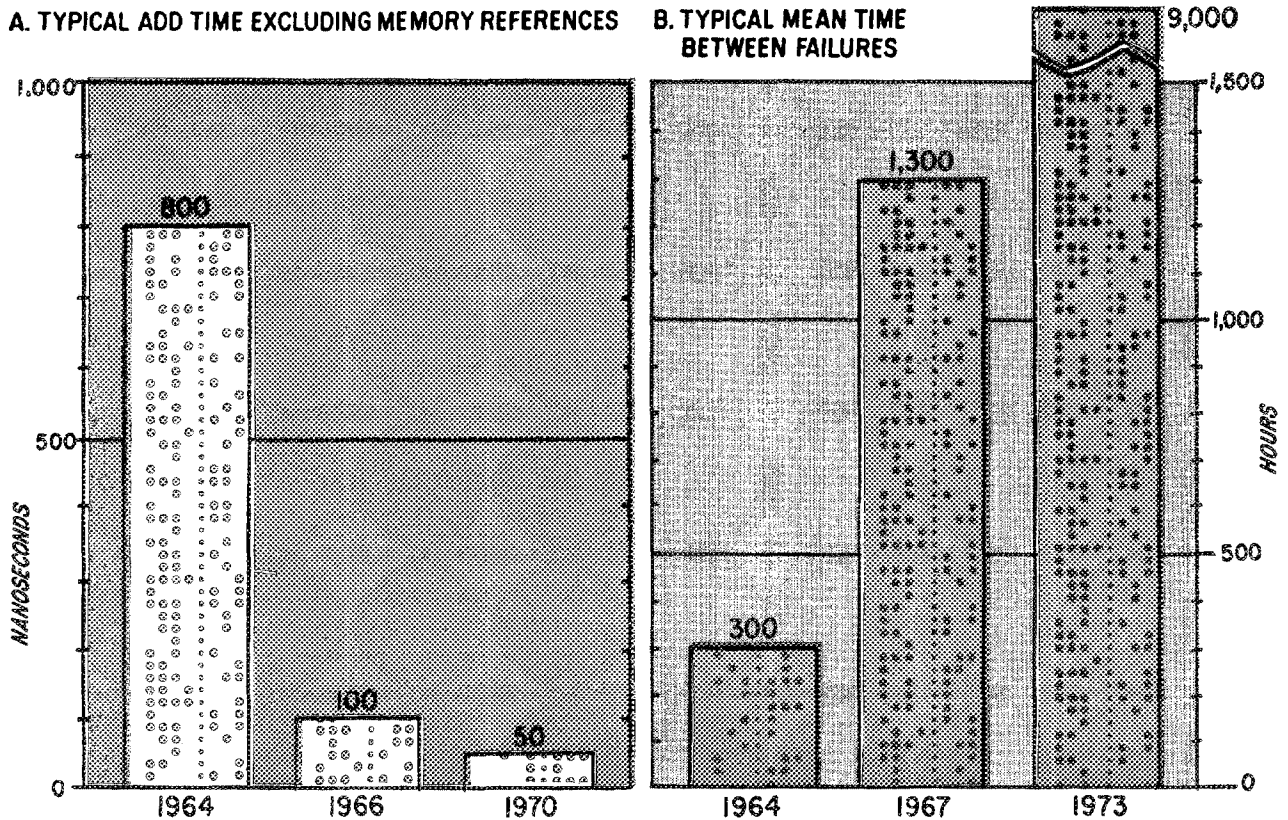
The systems will be what some of us would call more "communications-oriented." The heart of a typical system will be a communications "central" to direct incoming and outgoing data from a central point or points to the entire organization. Improved technology together with new services and economic factors will reduce significantly the cost of long-distance data communications, and the variety of services available will be greatly increased. Data and voice communications facilities within an organization, nationwide, and international, will be integrated and combined with other techniques, such as video phones, so that data and person-to-person communications will be revolutionized. Instant transmittal of data from all points in the organization will be economically feasible,

EXHIBIT 1. ANTICIPATED SHIFTS IN INFORMATION-PROCESSING EQUIPMENT COST FOR A TYPICAL MANUFACTURING COMPANY



SOURCE: The Diebold Research Program.

EXHIBIT II. ANTICIPATED ADVANCES IN COMPUTER SPEED AND RELIABILITY



SOURCE: The Diebold Research Program.

and highly improved means of voice communication will help top management to utilize effectively the data available to it.

Some of these improvements are available today. For example, a major diversified retail and manufacturing company is currently in the process of centralizing all of its nationwide data processing activities in one location. Cost is one basis for the plan, but improved management control of widely dispersed activities is an anticipated result.

2. *Information systems will tend increasingly to be "real time"; that is, they will reflect important and routine events as they occur.*

Real-time systems, such as those that American and Eastern Air Lines are now operating, will obviously be employed only where justifiable. But the increased economy of communications, together with developments to improve systems speed and reliability (see EXHIBIT II) and to reduce the cost of data collection, will make such systems increasingly common.

Many companies are moving in this direction. For instance:

International Paper Company, one of the sponsors of The Diebold Research Program, recently announced a plan to lease computers with an estimated value of \$10 million to form an information and control system described as the most comprehensive ever undertaken in the paper industry. The integration of nearly a score of computers into the new network will eventually provide full information on what is happening — *and as it is happening* — in International Paper's nationwide manufacturing, financial, scientific, and marketing functions. Conversion to the proposed system will be a long-range program starting immediately and developed over a period of years.

A significant aspect of the company's plans is that they are geared to impending developments in data input, throughput, and display. Future management information reports will be generated by high-speed printers, on screens, and by voice (audio response) — to name but a few of the communications methods contemplated. In addition, various computers in the system will be able to communicate with each other while serving numerous locations simultaneously.

New services will become available from information service centers. Credit reports; legal,

market, and technical information; and a variety of other special services will be available "on call" from regional or national centers. Some companies currently providing such services in published form are planning for service centers, and a forerunner in the legal-information field already is operating in New York.

3. *Systems flexibility for new applications will be vastly increased, and costs greatly reduced, through a broad range of new peripheral equipment developments.*

Many of these developments will be designed for special functions or industry needs, and they will be instrumental in changing the scope and nature of information systems. Advances will be of two types:

(1) Computer manufacturers will perfect lower-cost and improved-performance versions of devices and techniques that are today limited in use because of technical and cost factors. Strides in optical character recognition will help overcome the high cost of input of data (which currently runs from 20% to 40% of the total systems cost — and is a major obstacle in developing present systems as a management tool); cost improvements will be made in facsimile devices; and special multipurpose, low-cost units for data collection will be developed. Precursors of these devices are the data-collection system for general information of a large West Coast aerospace manufacturer and the special agent and teller sets used by airlines.

(2) New kinds of devices will change drastically the relationship between man and the machine system. Direct, remote-keyboard, or even voice input to the system will soon be a commonplace reality. An official of one of the largest U.S. corporations has indicated a minimum expectation of 1,000 such units on *managers'* desks within the next two to four years. Display techniques that provide direct readings of information in written or graphic form will be perfected further, with the possibility of modifying the data directly through the display or input-output device.

These kinds of devices will significantly increase the kinds of things the system can do as well as the ways in which management may use the system.

4. *Significant cost reductions and vastly expanded use of random-access files and memory will permit the drawing together on an*

integrated basis of the data needed to manage and operate the company, and provide instantaneous and flexible access to it.

A common, integrated data base will be substituted for the multiplicity of independent, disparate files now maintained. Data relevant to sales production, labor relations, finance, and other functions will be obtained from the same source, on a uniform basis, and in proper relationship to other information. In contrast to what can be done today, the information system will be able to respond on short notice to new, unforeseen questions, rather than only to those that have been preprogrammed into the system.

The companies working to achieve this goal — and there are several such firms — recognize the magnitude of the task. One major oil company has allocated almost two years simply to

How will the manager of the future use information-processing technology and other new analytical tools in his decision making? H. Igor Ansoff appraises the possibilities in "The Firm of the Future." See page 162.

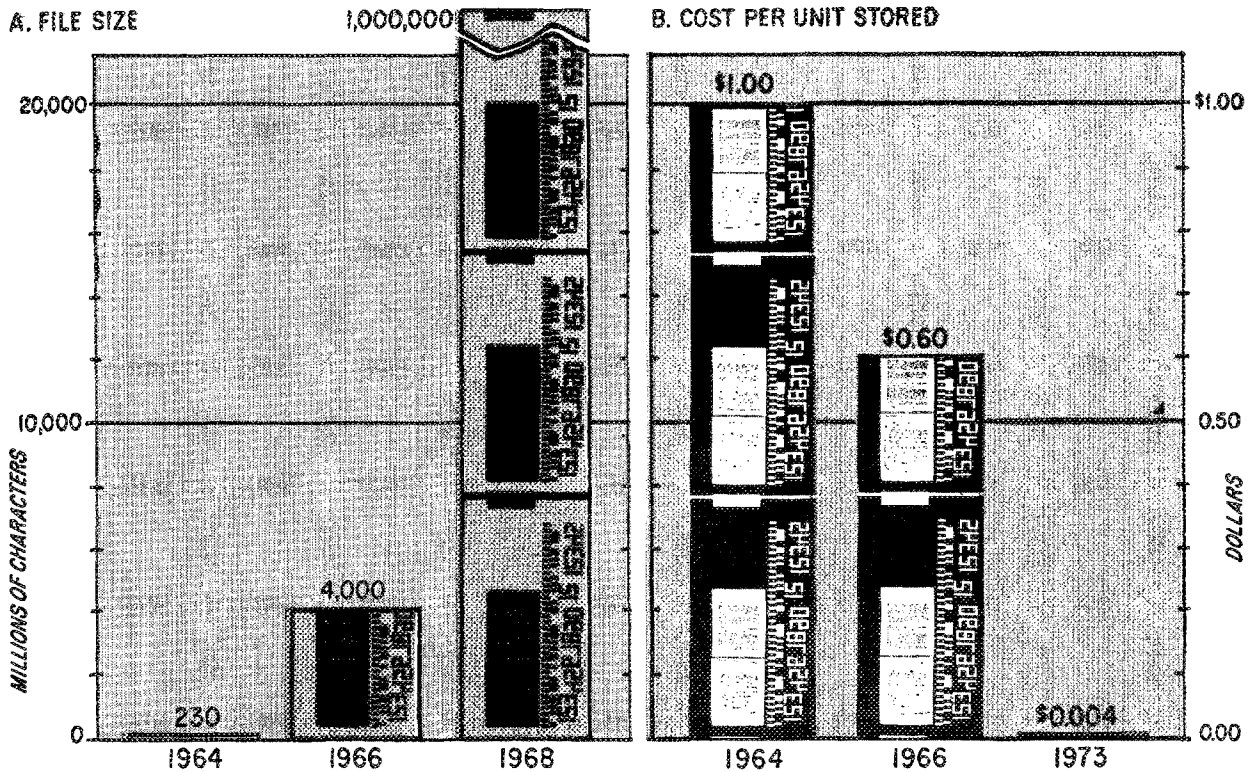
unifying its personnel records and files on an integrated, flexible basis. But the light should be worth the candle. Such a data base, imaginatively used, will be a startling aid to operations and to many kinds of decisions.

5. *A totally new data storage and processing capability — graphic storage and processing — will become economical and commonly available.*

Simply stated, this will consist of the equivalent of erasable, computer-manipulable, computer-modifiable microfilm. In this area of development some of the most significant technological improvements will take place (see EXHIBIT III). They will permit great economies in certain applications and allow totally new ones to be developed. Semiautomated drafting and design are in the offing; their imminence is shown by experiments already underway in the automobile and aerospace industries.

There are also promising applications for this new approach outside the manufacturing field — for instance, in insurance companies and commercial and financial institutions. But the chief benefit will result from the proper integra-

EXHIBIT III. TYPICAL IMAGE FILES
 ("Chip systems" with 300-millisecond access time)



SOURCE: The Diebold Research Program.

tion of these new storage and processing capabilities into the overall systems plan.

6. *Information storage and retrieval of technical, management, and general data will become an increasingly important aspect of information systems.*

From an equipment-development point of view, these storehouses of information with instantaneous access to data, and with instantaneous responses to a variety of information requests, depend on all the previously mentioned developments. Communications, special input and output devices, graphic and digital data-storage capabilities — all contribute to the general advance. There is an obstacle to widespread progress, but it is not related directly to equipment. Rather, it concerns how to structure the data so that the right information will be provided in response to a given question. It is in this area of indexing and handling of the relationship between the machine system and the data that breakthroughs will be the most difficult.

7. *There will be significant improvements in the means of communicating with the system — the so-called man-machine interface.*

Managers will be communicating directly with the system. Direct interrogation of the system will take place through keyboard input or voice input, and response from the computers will be in the form of printed, displayed, or audio media. For instance:

- An executive may ask the system for a particular condition — inventory, cash, production, or some other aspect of operations.
- Again, he may actually use a distant machine to solve a particular problem that requires computer time.

The question mark in development here is not technical know-how but management know-how. If the systems described were available and economical today, their value would be unrealized in most cases. The important missing element is the design and structuring of a whole system so that direct interrogation by management is meaningful. The equipment is only per-

EXHIBIT IV. INFORMATION-PROCESSING DEVELOPMENTS — SELECTED TECHNICAL PROJECTIONS

AREA	DEVELOPMENT	WILL BECOME AVAILABLE IN—										USER PRICE (IN \$ THOUSANDS)		CAPABILITY	
		1969	1966	1967	1968	1969	1970	1971	1972	1973	1974	MINIMUM	MAXIMUM		
DIGITAL FILE STORAGE	LOW-COST EXPENDABLE DISK			██████████	██████████	██████████	██████████	██████████					10	20	100-200 millisecond access, 5-10 thousand bits
	REUSABLE THERMOPLASTIC FILM			██████████	██████████	██████████	██████████	██████████					10	50	10-100 millisecond access, 500 thousand bits
	HIGH DENSITY, PHOTOCHROMIC MICROIMAGE					██████████	██████████	██████████	██████████	██████████			80	120	200-500 microsecond access, 400 pages per square inch
CHARACTER READERS	LIMITED FONT-PAGE READER		██████████	██████████	██████████	██████████	██████████						100	250	2-3 documents per second, 2-3 fonts
	MULTIPLE FONT-PAGE READER		██████████	██████████	██████████	██████████	██████████	██████████					200	500	8-15 documents per second, 6-10 fonts
	HANDWRITTEN DOCUMENT READER — FULL CHARACTER SET				██████████	██████████	██████████	██████████	██████████	██████████			120	250	30 characters per second, limited capacity
						██████████	██████████	██████████	██████████			60	150	50 characters per second	
IMAGE STORAGE AND RETRIEVAL	CHIP OR DISCRETE FILM	██████████	██████████	██████████									500	800	60 second access, 2-4 thousand pages
			██████████	██████████	██████████	██████████	██████████	██████████					10	50	30 second access, 1 thousand pages
	CONTINUOUS-ROLL FILM, MAGNETIC SCANNING, SEARCH LOGIC			██████████	██████████	██████████	██████████	██████████					400	800	120 second access, 5 thousand pages
					██████████	██████████	██████████	██████████				100	200	120 second access, 500 thousand pages	
						██████████	██████████	██████████	██████████			400	600	120 second access, 4 thousand pages	
							██████████	██████████	██████████			100	200	180 second access, 1 thousand pages	
COMMUNICATIONS	DIAL-UP FACSIMILE			██████████	██████████								Line: \$100-\$500 per month Terminal: \$25,000		2 pages per minute
	DIAL-UP DATA TRANSMISSION				██████████	██████████	██████████						Line: \$50-\$150 per 5 minutes Terminal: \$300		200 thousand bits per second
MULTIPROCESS SYSTEMS	CENTRAL SWITCHING MATRIX	██████████	██████████										150	250	Magnetic or mechanical
			██████████	██████████	██████████	██████████							50	150	Microelectronic semiconductor
	SUPERVISORY CONTROL PROGRAM	██████████	██████████	██████████	██████████	██████████	██████████						100	250	Priority and switching
			██████████	██████████	██████████	██████████	██████████					200	400	Optimum job scheduling	
					██████████	██████████	██████████	██████████				500	750	Adaptive control	

SOURCE: The Diebold Research Program.

missive; the real task is the development of the systems methodology.

Nature of Challenge

These seven lines of development, taken together, will be the technological basis of the information revolution. EXHIBIT IV shows the dates when some of the specific technical developments can be expected to be generally and economically available, and the precise characteristics and capabilities involved.

How certain is it that the gains will materialize as rapidly as anticipated? All the equipment advances imaginable will not create a management information system; only proper planning and painstaking effort will. By the same token, the most startling cost-performance improvements are not important unless the use of the advances makes a meaningful contribution to the practice of management. It is up to management itself to learn to devise the ways for effectively using these new tools.

Management today remains an activity significantly influenced by the individual and by personal approaches and attributes. Even the largest organization reflects the personal operating preferences of its leader or chief executive. So the utilization of management tools or techniques necessarily varies from company to company and from administration to administration. For example:

☛ President Johnson is reported to have been up and involved on several occasions during the night that the U.S. Navy made its first strike against a North Vietnam naval depot; but it is probable that President Eisenhower's management philosophy would have caused him to avoid becoming directly involved in operations.

☛ A senior management executive of my acquaintance, who recently left one company to join another, described his previous chief executive as omnipresent, either in person or by cable or telephone; but he described his present chief executive as only remotely involved, "although I would hear from him soon enough if the P & L dipped."

Both companies are highly successful.

It is easy to see that the use which such different kinds of chief executives would make of full, up-to-date, immediately accessible data and easier contact with subordinates would be different. Generalizations as to how the specifics of the chief executive's immediate job would change are therefore dangerous. In any case, the fact remains that information technology developments will change drastically both what the executive officer's company does and how it is done.

However, the functions involving day-to-day, top-level decisions and data analysis exist regardless of variations in management philosophy. They are exercised either by the chief executive officer himself or by others whom he designates. It is on these *functions* and the *way they are performed* that information technology will have one of its major impacts, whether the functions are considered those of the top manager or those of his subordinates.

The immutable fact is that the management team of any business or institutional organization will have new tools, new problems, and new opportunities as a result of future developments in information technology. The task of the management team is to apply the new developments to its company effectively. The success with which this is done will be a significant factor determining the competitive position and growth of the company.

Knowledge is of two kinds. We know a subject ourselves, or we know where we can find information upon it.

— Samuel Johnson (1709-1784)