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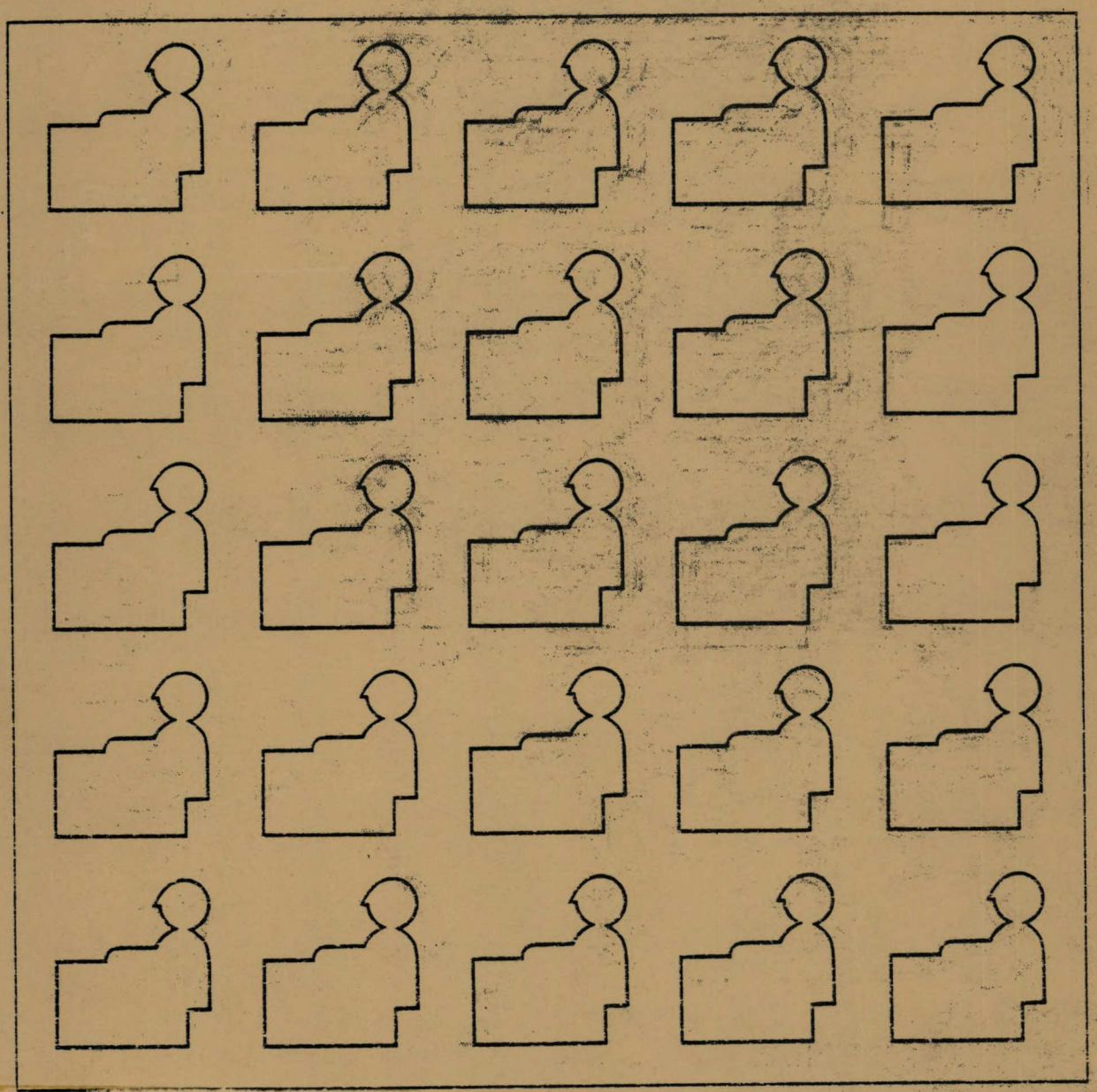
GENERAL OFFICE AUTOMATION ABSTRACTS



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GENERAL OFFICE AUTOMATION ABSTRACTS

The enclosed articles on office automation outline a variety of practical subjects and considerations devoted to helping prospective users understand and capitalize on this emerging technology. It is recommended reading for everyone who has an interest in increased office management effectiveness.

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INVESTIGATING THE ELECTRONIC OFFICE

by Don Tapscott

Intuition and early experience indicate that integrated office systems can have a strikingly positive effect on office productivity. The integration and application of computing, telecommunications, and information technologies in the office environment is already beginning to transform the ways in which people and organizations work. Moreover, it appears that the greatest benefit lies not in cost savings from increased clerical efficiency but in the augmentation of the abilities and effectiveness of "knowledge workers"—the managers and other professionals who work in processing, managing, retrieving, and communicating information.

Until recently, however, little work has been done to measure how new technologies can improve the effectiveness of office workers. The product planners, system designers, and market analysts producing the systems, along with the implementors, users, and choosers in the office, have all been forced to work in a vacuum. Without valid measures and data that quantify what these systems can achieve, producers have difficulty planning, designing, and marketing them. Those considering using office systems have had problems measuring their needs, customizing systems to their environments, and measuring the systems' effects. As a result, many systems have been inappropriate and have failed. Others, lacking a hard-dollar cost-justification, have never left the lab.

To measure the effects of office systems four different types of research can be used: 1) laboratory experiments; 2) true experiments in office settings; 3) quasi-experiments in office settings; or 4) nonexperimental designs.

Case studies, which fall under the nonexperimental design category, comprise most of the research conducted to date. Case studies can aid hypothesis formulation, but can rarely test hypotheses adequately because of their limited scope.

A number of laboratory experiments that examine the effects of integrated office systems, particularly computer conferencing systems, have been conducted. Although these experiments have produced interesting results, at present they are of limited value in office system research. They cannot re-create important parts of the office environment and their results often cannot be validly generalized. Research into the effects of office systems on productivity is still in its infancy: precise hypotheses that can be tested either in the laboratory or in the field are rare. Test groups typical of knowledge workers are not readily available for lab tests and the systems themselves cannot be mastered overnight.

The most appropriate research designs at this time fall under the category of quasi-experimental designs in field settings. These designs include some experimental controls but lack a random assignment of subjects to the studies.

Research that uses a quasi-experimental design can eliminate many threats to the validity of a study. It may possibly show how poststudy differences between test and control groups were caused to some degree by the system use.

For example, post-test changes in effectiveness of the test group might be due to events other than the introduction and use of the system. Such events should also affect the control group in a similar manner. If they do not, the changes may be attributed to the use of the system.

If observations of control and experimental groups are made only after testing, the observers cannot determine whether differences between the groups are caused by the experimental treatment or by initial differences between the groups. By using a pretest, however, this problem can be eliminated.

THE BELL CANADA STUDY

In 1979, Bell Canada began funding a project at Bell-Northern Research (BNR) to develop techniques for measuring and collecting data that could be used to assess the effects of electronic office systems on their users. The research is being conducted by a multidisciplinary team in the custom systems division with help from behavioral scientists at Bell-Northern Research and BNR INC.

In a pilot study using a quasi-experimental design, 19 knowledge workers were given electronic workstations on an integrated office system that provided electronic mail, information retrieval, word processing, administrative support, and data processing. These workers' attitudes, time use, communications patterns, etc. were compared with those of a control group of 26 in a pretest-posttest, quasi-experimental research design. The subjects' activity on the system was monitored daily.

Both groups were pretested in August 1979. The test group went on the system in September and a post-test of both groups was conducted the following May.

Three members of the research staff were also members of the test group, learning the system and doing their work on it. Pretest and post-test measures confirmed that they did not differ significantly from other members of the test group.

The activities of the test group were continuously recorded. Measures built into the system recorded log-in hours, commands used, applications used, communications patterns, etc. There is, in fact, a record of all activity on the system. To ensure the users' privacy, and thus their trust and cooperation, the content of messages, text, and files generated by the test group was not examined.

Before the researchers embarked on the pilot project, they conducted a survey of divisional managers to determine managers' views on what changes would constitute improvements within the organization. This survey facilitated the design of both the pretest instruments and the office system itself.

Structured interviews were held midway through the pilot project. These inter-

views helped the researchers to determine the users' initial progress in learning the system, what extra training they required, and what modifications to the system were needed.

The measurement instruments developed for the pilot included a prestudy questionnaire on organizational effectiveness, an extensive survey questionnaire, a form for determining with whom respondents communicated during a typical specified time period, an activities/communication log, a method of system monitoring, and structured interviews. The relationship of these instruments to the research design is indicated in Table I.

TABLE I
Measurement Instruments

PRETEST	POST-TEST
1. Questionnaire 1 examined —system requirements —communication in the organization —information use, access, and problems —attitudes to technology —job design —quality of working life —demographic data	1. Questionnaire 1 again, plus items on attitudes towards the pilot
2. Network interaction analysis —examined the communication network	2. Same
3. Activities communication log —a detailed account of time use and communications patterns	3. Same, plus data compared to No. 4 below
	4. Data generated from the system, e.g., —kinds of applications used —system use over days, weeks, months —learning curve —commands used —computer communications patterns
	5. Post-test interviews of experimental group —examined problems with system, training, documentation and features desired

The test group consisted of seven managers, eight professionals, and four administrative staff. While this group cannot be said to represent typical office workers, it did contain a variety of different kinds of employees. The managerial group contained one executive, one administrative manager, and managers involved in systems development, research, and consulting. The professional group was made up of a psychologist, a management science specialist, two programmers, and two engineers. Most of the administrative staff were secretaries.

The control group consisted of nine managers, 11 professionals, and six administrative staff.

As previously mentioned, office populations can rarely be randomly sampled for study subjects. Consequently, the test group was selected by using other criteria. Some of these had more to do with the internal needs of the company than the needs of the study. To be successful, a good research design and system must correspond to genuine needs of the workers and organization involved.

In an attempt to make the findings more representative, similar research projects are now being conducted in offices in a variety of different companies.

SPECIALLY DESIGNED SYSTEM

The Office Information Communication System (OICS) used in the pilot was designed specifically for the study, not for the marketplace. The system consisted of an integrated set of application programs running on the Unix operating system. Users logged onto the system through display terminals hardwired to a DEC PDP 11/70 computer. The terminals did not have any special function keys or other intelligence. Once the user had logged on, he had access to any part of the system by typing the command name associated with the desired facility. (The office system architecture is shown in Fig. 1.)

The pilot system was composed of the following subsystems: electronic messaging, text processing, information retrieval, administrative functions, and analytical tools.

The COCOS electronic mail system, developed by Bell-Northern Research, lets users compose, send, forward, reply to, and file electronic messages. For paper correspondence, users were prompted by a program that automatically generated formatted memos and letters. The mail log system permitted tracking of paper mail in, out, and within the office. With the synchronous messaging function, a user could permit short messages to be sent to him by other system users while he was working at his terminal.

Several text editors were available; a line-oriented editor with a terse user interface was used most. A powerful text formatter could be used to structure texts to produce reports with pagination and numbering, hyphenation, justification, page numbering, point numbering, and a table of contents. Automatic spelling checks, which use three dictionaries as databases, were provided on the system, as were readability indices for examining the content of text. Other features included sorts, merges, text and data manipulations, and some table, figure, and graphics abilities.

The office system provided an information retrieval subsystem to maintain and query databases for any type of information. A project bibliography and a conference and seminar schedule were among the first databases put on this facility.

The OIC system provided several administrative tools:

- personal log (what was done when)
- to-do file
- cost tracking
- schedules
- coming events
- time reminder
- phone lists and telphone area codes
- acronyms
- desk calculator

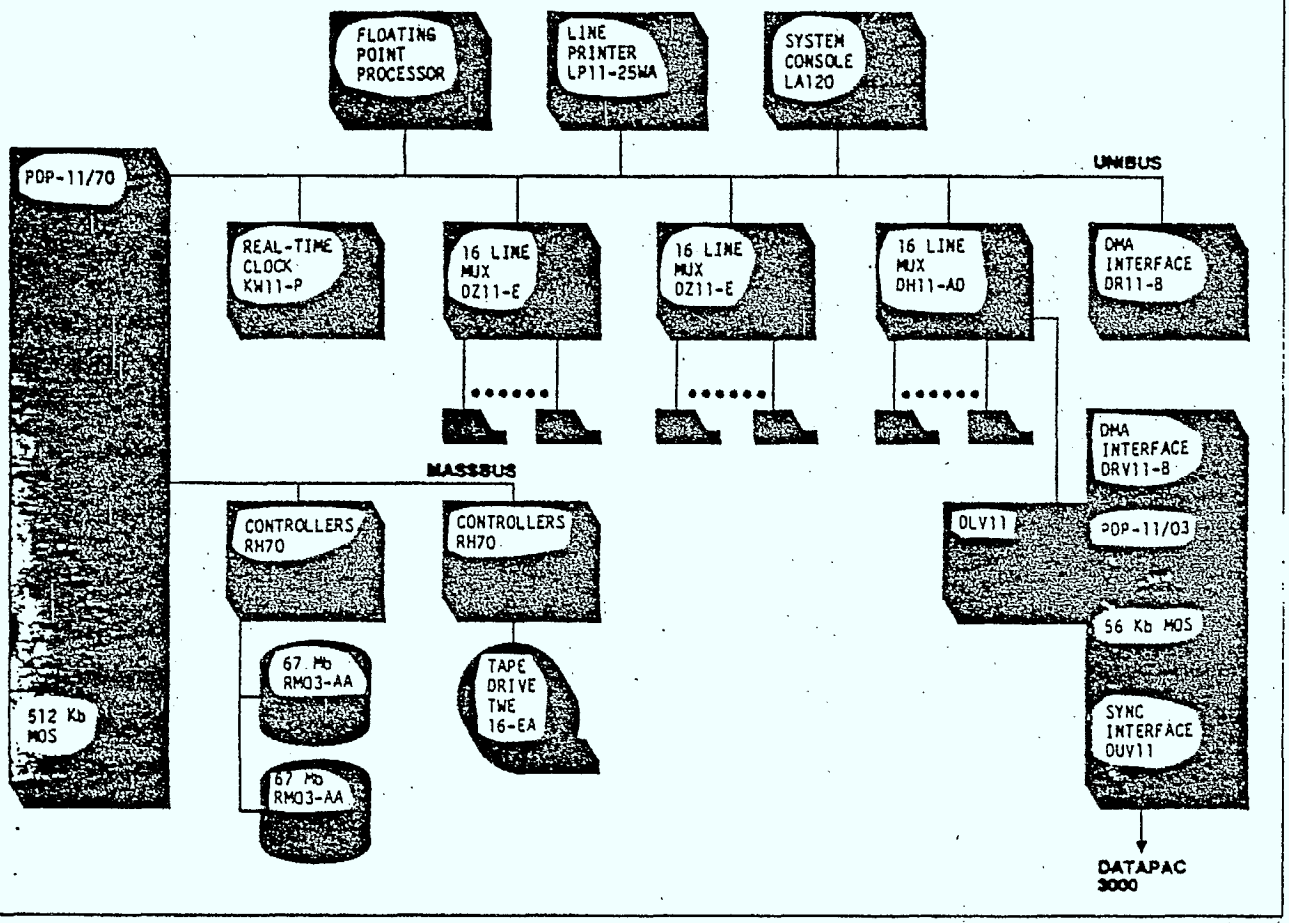
Among the analytical tools on the system was an interactive statistics package. This package could handle a variety of statistical applications with simple graphical output that ranged from calculation of means to regression analysis. For basic arithmetic and scientific operations, a simple calculator was provided. Data processing facilities were also incorporated into the system.

Tests of selected data conducted by researchers at the University of Waterloo indicated that the Bell-Northern Research pilot study had extraordinarily high data reliability. Still, like most studies, this one had its limitations. They consisted of the difficulties involved in performing field studies in general and office system field studies in particular; the unique nature of the office environment where the study was conducted; organizational changes; staff turnover; and changes in the content of work in the office environment over the 10-month pilot study period.

These limitations hampered the ability of the researchers to generalize the findings to broader populations of office workers.

FIG. 1

ARCHITECTURE OF THE OFFICE INFORMATION COMMUNICATION SYSTEM



The pilot study findings are best viewed as an investigation into the impact of one electronic office system on a particular office. Viewed in this manner, they can be used to generate more detailed and solid hypotheses for verification in other situations.

FINDINGS OF THE STUDY

In general, the pilot system apparently improved the users' communications, time use, access to information, attitudes toward office system technology, and quality of working life.

Between January and June, the members of the test group who participated in the study from its inception averaged 3.7 hours of log-in time each day. The whole test group, including members added to compensate for attrition, averaged a daily log-in time of 3.1 hours.

Use of the computer messaging facility steadily increased over the time of the pilot study (see Fig. 2). During the first seven weeks of the study, users sent an average of two messages a day. The last seven weeks saw an average of eight messages a day.

The research team attributed this increase to several related factors. A simpler and more powerful messaging system was installed in the eighth month of the study. New features added to the system encouraged employees to use it more. The messaging network was expanded to add new users inside and outside the company. Though users could learn the technical aspects of the system quickly, it took some time before they learned how to integrate the system into their work habits.

Changes made in the messaging system appear to have had the greatest impact. More messaging tools were made available, such as the ability to forward and annotate messages to various distribution lists. The messaging system was made more "friendly," able to recognize spelling errors or prompt the user for more information if the name entered was not in the corporate directory.

Messaging system use varied widely both between users and over time. Over the last nine weeks of the pilot some users sent an average of only three messages per day, whereas others averaged 12 per day. There was, however, less variation among users during the last period. Moreover, the research staff had expected system use to fluctuate greatly, for users were often out of the office, involved in meetings, and so on.

The number of commands used by each user per week fluctuated considerably but showed no marked increase over the time of the study. The number of different commands used by each user per week, however, slowly increased over time.

The main uses of the system were text editing and messaging. During the first four months of system operation, the average user generated upwards of 400 pages of text. This extensive use of the text editing tool lends weight to the hypothesis that managers and professionals will use keyboards and text editing if they are provided with useful features, intrinsic rewards, and training.

The percentage of the day spent by the test group in communications activities increased from 53% to 58%, whereas the figure for the control group decreased from 51% to 45%. The reason for the latter's decrease is not clear. The increase for the test group is likely due, in part, to reduced time spent in administrative noncommunication activities. Post-test results indicated a reduction in telephone use and in one-on-one meetings for the test group. These results support the hypothe-

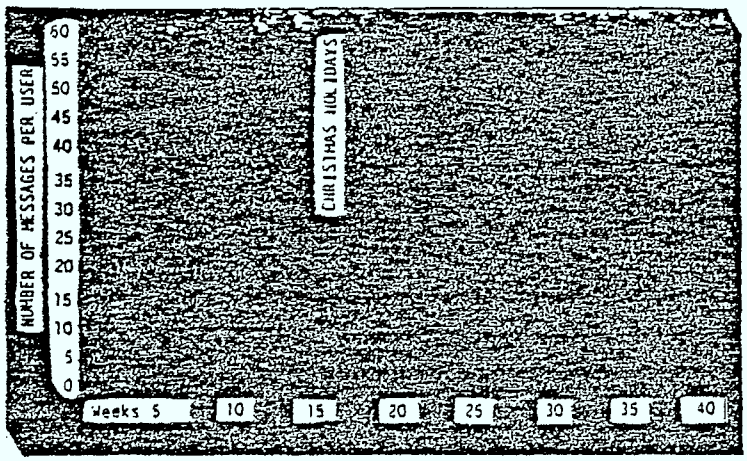
sis that computer messaging will reduce not just the volume of paper mail, but also the use of other forms of communication.

The percentage of time an employee spent daily in activities not considered an interruption increased for the test group. These data are important for the cost-justification of office systems, for a reduction in interruptions can result in quantifiable time savings and more or better quality work. Time spent in communication among peers also increased, a change company managment had deemed desirable.

The percentage of attempts to contact fellow workers that failed (for example, from busy phone lines) decreased. Reductions in such shadow functions carry measurable cost-benefit implications. In this case, there were average time savings of almost 10% of the employee's day—savings resulting from improvements in the communications process alone. In most cases, these time savings appeared to have been reinvested in producing more or better work. In addition to measures of actual time savings, most employees expressed the opinion that the system had saved them time.

FIG. 2

USE OF THE COMPUTER MESSAGING FACILITY



GROUPS JUDGE RESULTS

The results of the test group's subjective evaluations of time use were mixed. The amount of time that users judged to be useful increased, but the amount of time they judged to be important did not. The amount of time judged to be time effective increased for both groups, but attitudes toward other employees and communications with them improved for the test group only.

The research group hypothesized that the disparity between perceived "information needed" and preceived "information received" indicated by the pretest would decrease for the test group. This did not occur. There were a number of improvements between the pretest and post-test in the perceived "information received." But the perceived "information needed" increased correspondingly. These findings suggest that as access to information improved for the test group, expectations increased, as did perceptions of what was required.

The increases in information received may have been due to a varitey of system-related factors: users' access to the information retrieval system, on-line access to previously written reports, access to previous messages, and better communications with other employees (for example, supervisors) who had the desired information.

Employees in both groups estimated that they could save a substantial amount of time if they had access to specific information such as relevant publications, upcoming conferences, management policies, minutes of meetings, etc.

Though projected time savings are completely subjective and likely overestimated, two findings stand out. Both groups thought, first, that they had received inadequate information and, second, that better access to information could have saved them about half the time they spent looking for it. Surprisingly, the test group members indicated that they could have saved more time than the control group if they had had better access to information even though they had already been using an information retrieval system. One possible explanation for this attitude is that since test group members had experienced the benefits of an information retrieval system, they expected that still better access to information would yield still better results.

The test group's attitude toward technology and its potential benefits became more positive with system use. Preferences for the use of a keyboard to compose written material grew to the point where users indicated that they themselves typed and edited 75% of what they composed. There was an increase in users' positive opinions of the abilities of fellow workers to use an on-line office system in their day-to-day work. Attitudes regarding the greatest potential benefits of office systems shifted from an emphasis on clerical, typing, and administrative tasks to an emphasis on professional time savings and improvement of the quality of decisions.

Attitudes toward the office system itself were on the whole positive. Users generally indicated that the system was not difficult to use, that they felt comfortable typing at a terminal, and that the system was not down too much.

The test group generally felt that a better users' manual was needed, that the system's error messages were of little value, and that the system should be more tolerant of users' mistakes. The group also found access to printers inadequate and system services degraded during peak workload periods.

Most users felt that the system had improved their ability to do their jobs. Improvements were seen in communications, information access, preparation of written material, and worker collaboration. In fact, most users felt that both the system functions and the size of the user community should be expanded. The functions that users wanted most to see were automatic project accounting, computer conferencing, and memo and letter templates.

SYSTEM IS EXTENDED

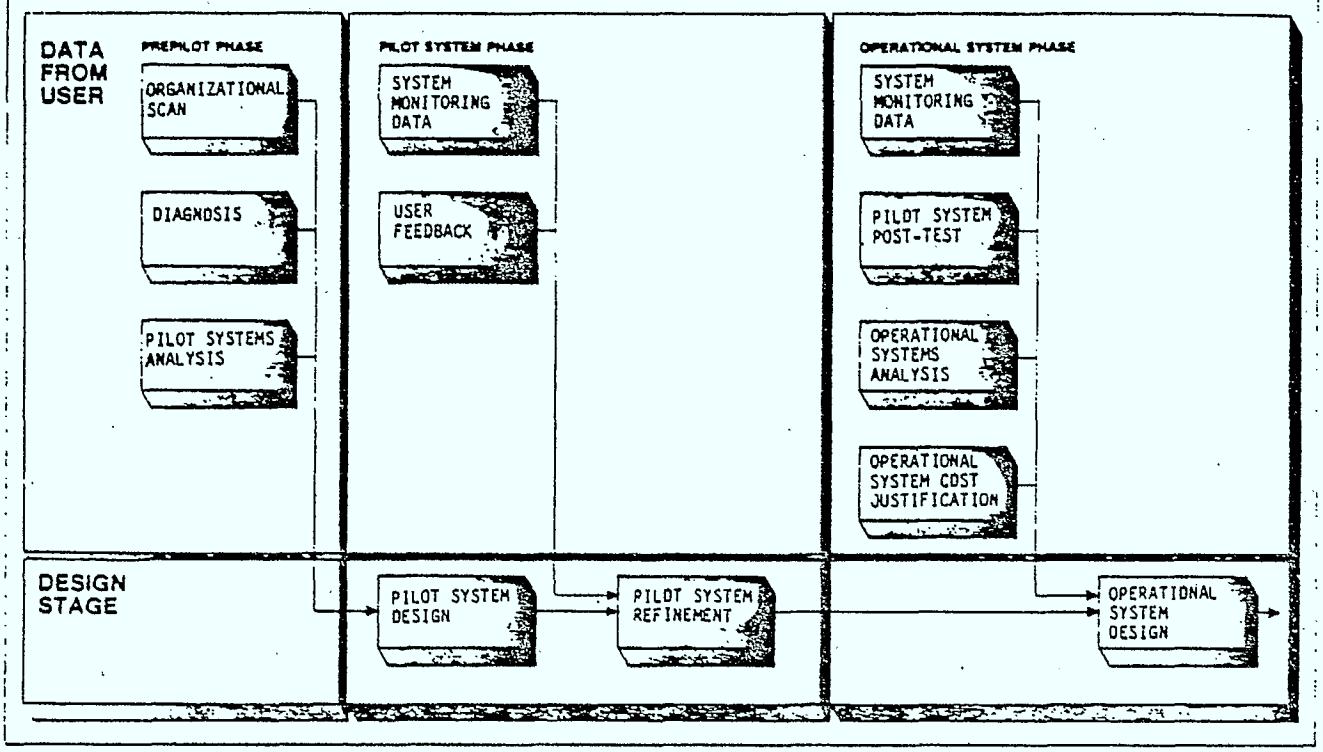
Using the results of the pilot study, the research group was able to present a business case to management to extend the project to an operational system covering most of the custom systems division. Managers, project leaders, administrative personnel, and other employees are now being placed on the system.

The operational system has added several features to the ones provided on the pilot system. User profiles tailor the system's user interface to the skill level, requirements, and preference of each employee. For example, some users prefer a menu-based interface. The user calls the menu, which appears on the screen. He then chooses the function he needs by typing in the function number listed in the menu. Users who run into trouble are assisted by a computer-aided instruction facility.

An information management facility will be introduced this year. It will handle a set of basic functions that enables users to create and manipulate databases. With this feature users will also be able to generate and display forms on the screen and use them to capture and update information. Another application being introduced is a project control

FIG 3

THE USER-DRIVEN DESIGN METHODOLOGY



system based on the custom systems division's project management methodology. This subsystem will assist employees with status reports, financial accounting, and tracking for projects.

The methodology developed for and used in the OICS project is now being used to evaluate the impact of office systems in other environments. The method divides customizing into three phases. During the prepilot phase, data are collected to design the best pilot system possible. During the pilot phase, information is drawn from the users and from the system itself to help evaluate and refine it. And during the operational office system phase, post-test and system monitoring data are combined with systems analysis data to enable the specification and cost-justification of a full operational system for the whole organization. This process is illustrated in Fig. 3.

With subsequent tests Bell-Northern Research's ability to collect valid evidence will grow, as will the evidence itself. This will help to provide the information needed for useful product design, successful marketing, and successful implementation of the new technology. The result should be better designed office systems—used, accepted, and enjoyed by more office workers. ✱

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REPRINT

MODERN OFFICE PROCEDURES

WHITE PAPER REPORT

MANAGING HUMAN FACTORS IN THE AUTOMATED OFFICE

by
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Ultimately, the greatest impact of new technologies will be on the people who work in offices, from the chief executive officer down through the ranks of managers, professionals and clericals to the newest trainee in the mailroom. Technologies in the future will lead to behavioral changes, changes in the way people work and the way in which an enterprise is organized and managed.

In essence, this paper is an attempt to create an awareness of what is happening in the office, a recognition of the implications of change. The greatest potential of new office technologies lies in their ability to help improve the operating effectiveness of office personnel. If those improvements are to be achieved, however, great skill must be exercised in managing the process of change. Job aspirations, career paths and, ultimately, the realization of human potential hang in the balance.

The office of the past

The ways activities are carried out in today's offices are the outgrowth of a long series of programs aimed at bringing some sense of orderliness and efficiency to the process. The programs began years ago when Frederick W. Taylor and his followers introduced principles of scientific management. Duties were analyzed, divided up into common categories and standardized. Methods and procedures were devised so that routine tasks could be carried out in assembly line fashion. Time standards were developed and incorporated into performance incentive systems. Order and efficiency were the watchwords in this factory-like approach to the management of office operations.

The introduction of machines into the office added to the trend. Pictures of early offices contrasted the clutter and confusion of roll-top desks to the efficiency of orderly rows of Gibson girls operating the latest in typewriters, adding machines and, later, bookkeeping machines. With the advent of punched card machines the equating of the office to the factory reached its zenith, for here were machine workers operating noisy, mechanical machines in a prescribed series of steps, punching, sorting and collating a common medium, a deck of punched cards, and eventually producing the desired end products, files and reports.

Punched card equipment became the first significant change in office organization. The technology center was established, separate from the rest of the office and populated by machine specialists. It started as the tabulating department, later became the punched card department, and still later the data processing department. Its inhabitants became increasingly proficient in the use of their machines, developed their own jargon and began establishing a technological mystique. Those people still left in the office proper saw the first symptoms of technological elitism.

The next development was the computer. Actually, computers never did come into the office. Rather, they went directly into a technology center, usually the data processing department, and rapidly became the premier office

technology. Office functions susceptible to mechanization were identified, computer-based systems were developed and the work was physically moved to the data center.

This process has continued for the past 25 years, and the achievements of the data processing fraternity have been outstanding. In fact, such activities as airlines reservations, credit card billing and check processing owe their current existence and continued viability to the powers of the electronic computer and the genius of those who make the machines operate.

Not all information in the office is susceptible to logical definition and stored program manipulation. In fact, most of it is not. For example, text expressed in words, sentences and paragraphs cannot be manipulated by a stored program, except in very rudimentary ways. Text can only be manipulated by human beings. It is this distinction which makes word processing equipment substantially different in principle and in usage from computers. Word processing equipment requires a direct one-on-one interface between a human being and a machine to carry out the function of manipulating and editing text.

However, when word processing equipment was first introduced, this distinction was ignored. The approach taken to its use paralleled that of data processing. The functions of secretaries were rearranged, and typing was taken out of the office and assigned to the new technology center, the word processing center. In a classic case of history repeating itself, the technology center developed its own jargon, its own trade associations, its own gurus and its love affair with technology, in this case, word processing equipment.

But text is not data. Text is more personal: it represents thoughts and ideas. The notion that text could be handled exclusively in a technology center did not sit well with many managers. The history of word processing has been one of seeking alternative organizational approaches which would facilitate the application of machine capabilities to text editing without moving the function out of the office to the traditional technology center.

Similarly, growing dissatisfaction with the service being provided by data centers, and with the bureaucratic hassle oftentimes associated with computer use, has led management to insist that data processing capabilities be distributed throughout the enterprise, rather than remain under the exclusive control of the technology center. This trend has been supported by the introduction into the office of minicomputers, of timesharing networks and similar telecommunications-based computing capabilities, all at substantial improvements in economics.

The office of today

Today's office is marked by a gradual movement to break down barriers between technological haves and have-nots and to distribute powers of data processing and word processing equipment throughout the office workforce. It is also marked by an explosion in other technologies, all of which are being interconnected through telecommunications. One would be hard-pressed to identify all of these technologies, and today's list could become quickly outdated by tomorrow's announcements. But a few examples will illustrate current technology trends.

Information in offices is communicated in writing and by word of mouth. The most common communication media are correspondence, printed material, face to face meetings and telephone conversations. Each of these activities is being affected by new technologies. Electronic mail is becoming almost a generic term to describe various technologies whose purpose is to speed up the movement of written material. Examples include sub-minute facsimile equipment which transmits the image of documents already created, communicating word processors through which letters are typed in one location and printed in final form in another, electronic message systems where messages are moved from screen to screen over telecommunications networks and, ultimately, electronic correspondence systems in which letters are transcribed electronically, moved, responded to, filed and retrieved without ever being transferred to paper.

Similarly, information recorded electronically can be reformatted as desired and transmitted to photocomposition equipment for ultimate conversion to printed matter. For oral communication, audio and video equipment are being used to facilitate teleconferencing, the conduct of meetings where participants are in separate locations. Telephone usage is being augmented through the use of voice message systems. Traditional technologies like micrographics are being modernized through interfaces with computers, word processors and other electronic equipment. The wave of technology is impacting every medium used in the office for storing information — paper, filing cabinets, books of account, magnetic media, microfilm and, ultimately, the brain itself.

Although machine capabilities, capacities and methods of operation vary, advanced office technologies have several characteristics in common:

1. They are all telecommunications-based and thus not only process information but move it.
2. There are no longer separate technologies; instead, with data processing equipment taking on word processing capabilities and vice versa, with microfilm retrieval being aided by minicomputers, with a combination of telecommunications and computers being used to facilitate voice messaging, traditional machine distinctions are blurring.
3. They are moving inexorably toward an integration in which networks of machines, interconnected through telecommunications, are used to obtain, process and communicate information and manage the media used to store that information, whether the information is in the form of data, text, image or voice.

The office of the future

This network concept is the key to understanding how advanced office technologies will impact office personnel, both those who are steeped in technology today and those who are not. The network concept postulates that as time goes on, all the powers of modern office technologies will be available to all office personnel in all work locations, wherever it is possible to make an interconnection with the network. No longer is technological power available only to the technologists. Instead, every office worker will have at his or her fingertips an increasingly powerful array of capabilities, tools to help improve job performance.

The implications of the network concept are extremely far-reaching. To the traditional technologist, the data processing professional, the word processing specialist, brought up in a single, well-defined technology, the future calls for mastery of not one but a number of technologies, operating under the umbrella of the network. The dominant technology is not data pro-

cessing, or word processing or any of today's technologies. Rather, the dominant technology is the network. Other technologies are subordinate to it.

To go one step further, technologies use the term "application" to identify a function in the office which can be handled on a particular machine. For example, data processing applications are those office functions which can be handled on a computer in a cost-effective way. The same definition applies in the use of word processing equipment, micrographics equipment and other kinds of machines. The decision as to which applications can be transferred to a machine is a function of the capabilities and limitations of a particular technology and the economics of mechanization. However, when one deals with networks of technologies, the limitations and peculiarities of a particular technology no longer govern use.

Because of the changes associated with the introduction of networks, the impact of advanced office technologies on the technologist will be very great, and sometimes traumatic. The impact will be even greater on the non-technologist. The traditional approach in the office has been to turn technologies over to specialists who then will provide services to non-specialits. The history of data processing and word processing are good examples. In a world of networks, however, the role of the specialist is to design and manage the network to provide an increasingly powerful array of capabilities to non-specialists, who may choose to use them, or not, based on individual perceptions of value. The ability to receive and respond to mail electronically; the ability to keep track of one's calendar, of ticklers and of personal files; the ability to edit text on a screen; the ability to participate in teleconferences; the ability to handle voice messages as easily as written messages; the ability to select and retrieve information from machine-stored files, in any form desired, and from external data bases as well; the ability to postulate and test alternative course of action through mathematical simulation; the ability to do local computing and to take advantage of videotex services; these and a host of other capabilities will be provided to non-technologists through networks. Further, since these capabilities are intended to support intellectual activities, their greatest value will be to managers and professionals, who will be able to use them to improve their own operating performance.

FLARING: AN AILMENT OF COMPUTER CONFERENCING

Communicating through machines can lead to unanticipated and at times undesirable results, as illustrated by a phenomenon in computer conferencing called "flaring". Computer conferencing is a technique for conducting a meeting where the participants are in several locations and communicate with one another through terminals. All communications are recorded on a computer and are available to all meeting participants, thus constituting an on-going set of meeting minutes.

Computer conferencing has been especially valuable in carrying out projects where project team members are geographically separated, because no meeting need ever be scheduled. At a time convenient to his or her work schedule, each team member can contact the computer, read what has been entered by the other members, enter a report on local progress and offer additional comments and reactions.

In this latter area, however, the shortcomings of communicating through machines become evident. It has been found that when a team member disagrees with another, the words entered into the terminal to express that disagreement are much stronger and harsher than would ever be the case if the two were face to face. Needless to say, the reaction and response from the other end to such verbal abuse is prompt and equally strong, thus escalating a disagreement into a battle.

This phenomenon of verbal overkill has been given the name "flaring" and personnel experienced in the use of computer conferencing have become proficient at spotting its occurrence and moving quickly to dampen the response. That it occurs in the first place is indicative of the fact that the many benefits associated with a technique like computer conferencing do not come free. Any time one substitutes communication through machines for face to face communications, unintended distortions can occur. If these distortions are not promptly corrected, then the chances of total communications breakdown increase dramatically.

The changing workforce

What kind of people will work in the office of the future? The answer is not entirely clear, but the evidence to date suggests that they will be different, perhaps substantially different from the office workers of the past. In fact, the changing nature of the office workforce ties in well with what is happening in technology.

First, the educational level of office personnel is rising and, as routine office tasks are taken over by machine, the remaining work tends to be more intellectual. Since the capabilities offered by advanced office technologies tend to support intellectual activities, the chances of those capabilities being used and used quite successfully are very good.

Second, there is an increasing tendency on the part of office personnel to want to see the job through, to be responsible for an activity from its inception to its completion. Today's office personnel want to see jobs through from beginning to end and be given wide latitude in determining how the job is to be accomplished. Here again, the availability of a vast array of new capabilities provided by advanced office technologies offers strong support for pursuing alternative courses.

Third, the concept of participative management, of getting more people involved in the decision-making process, is gaining greater and greater acceptance. So also are quality circles and other techniques, all aimed at improving operating performance as a team effort. The cogs in a wheel approach, where someone else is driving the wagon, is passé. The trend now is toward personal participation in determining the best way to get a job done.

Fourth, the world outside the office is exploding with new technologies. Video games, home video systems, personal computers and a host of other innovations are becoming commonplace. The mystique of electronic technology is disappearing in this new wave of consumer products. People are becoming more comfortable with machines, and that comfort level is flow-

ing over into the office. Fear of the unknown, which was the basis of much of the resistance to technology, is less and less a factor because technology is becoming less of an unknown, thanks to the external environment. The questions being asked today do not challenge the need for a machine; rather, they ask how the machine can help improve operating performance.

To these factors must be added the growing awareness on the part of senior management of the need to improve office productivity.

Productivity

As the move into the information age accelerates, the ratio of office workers to non-office workers increases, and so do office costs. In many cases, office costs are rising at a rate which is substantially out of proportion with cost increases in other sectors of business operations. Senior managers are becoming aware of this phenomenon and its potentially adverse impact on business profitability. Companies are beginning to introduce formal programs to get a better return on the investment in office operations by improving the productivity of the office workforce. In the past, such efforts were aimed at the clerical workforce through improved methods and procedures and through mechanization. However, any analysis of office costs quickly reveals that the major cost elements in the office are not associated with clericals but with managers and professionals. In most cases, they account for upwards of 75 percent of all office costs. If meaningful and significant results are to be achieved, office productivity improvement programs must concentrate on helping managers and professionals improve their own productivity. Thus, the motivation to find new tools and techniques to achieve managerial and professional productivity is not just idealistic; rather it is an economic necessity, if enterprises are to survive and prosper. The future office will be the site of intensive efforts by senior management to streamline office operations, to improve the economic viability of the office and to maximize the contribution of the office to the success of the enterprise.

Impact on technologists

One would think that technologists would adapt easily to the changes taking place in the office. In fact, they do not. The term technologist is perhaps a misnomer. It is intended to identify those office personnel who are familiar with sophisticated office machines and identify with a particular technology — computer programmers, word processing supervisors, micrographics specialists and so on. As the distinctions among technologies blur, as the network concept becomes more prevalent and as the users of technologies proliferate, the technologist will be swept up in a world of change, change which at times may be quite traumatic. Data processing personnel are already going through an identity crisis as they contemplate all of the new office technologies. So also are word processing personnel as witnessed by their efforts to become information processors.

Adding to the identity crisis is the paradox of specialization. Technologists must take a very broad view of technology and its uses to understand the network concept, the integration of previously separate technologies. They must be equally adaptable in accepting the view of technologies as a reservoir of capabilities to help improve operating performance rather than a series of machine applications. On the other hand, bringing the network concept to fruition and engineering the interfaces among technologies demands of the technologist a level of specialized expertise unparalleled in the history of the office.

Concurrently, as technological mystique lessens and the number of equipment users grows, the technologist will be looked at with greater appreciation and will be respected as the facilitator, the helpmate, the one who makes things work. The opportunity for broadening one's horizons and pursuing new career opportunities will be very great. Whether technologists will greet with enthusiasm or regret this move out of the pristine walled-in world of a single technology into the real world of many technologies remains to be seen.

On non-technologists

To the non-technologists, the marketing manager, the economist, the engineer, the tax analyst, the future office provides more and more tools to help get one's job done well and on time. No longer can the lack of tools or the inadequacies of the system be blamed for poor performance. It is up to the individual, the manager and the professional to pick and choose those tools which will be most helpful. In the old days, when an application was put upon the computer, its usage was mandatory. As of the cutover date, everyone had to use the new computerized payroll system. Not so with advanced office technologies, however: their usage is entirely voluntary. Despite that fact, in an atmosphere of heavy emphasis on improving productivity, the burden will be on the manager and the profes-

NEEDED: EXPANDED EDUCATION

Any discussion of the changes taking place in the office and their probable impact on people leads inevitably to the question of how to train office personnel to cope with this world of change. No easy solution is evident. In fact, it is a case of first having to educate the educators.

Computing is the most mature technology and it is well supported in the academic world. Advanced degree programs in computer science are available at many universities. When one branches out into other technologies, however, or contemplates a future of networks of technologies, the academic support is sparse. In fact, acceptance of the network concept and its implications is no more evident in the academic community than it is in the various technological communities.

Administration is another academic discipline which applies to the office and is offered at a number of universities. However, the tendency has been to minimize the role of technologies in such courses and to concentrate on traditional office activities. Thus, the disparity between the technologist and the non-technologist begins in the educational process and is reinforced when one eventually goes into the workplace.

Equipment vendors have been a traditional educational source for office personnel and still are, although the economic margins available on some of the smaller machines do not provide much funding for investment in such programs. The efforts of vendors are being buttressed and sometimes supplanted by firms specializing in machine education. In both cases, however, the emphasis is on machines and their operation, and the breadth of the effort

sional to make optimal use of the tools available.

The capabilities offered by modern office technologies fall into two broad categories — improved access to information and faster movement of information. The two often tie together, but they have different characteristics. Improved access to information provides the ingredients for making more intelligent analysis of alternative courses of action. Speeding up information flows can help improve responsiveness to changing business conditions and demands.

Improved access

At present, managers and professionals have only limited access to information stored on computers, usually to selected files for which special systems have been designed to provide such access. Most computer-stored information, all word processing-stored information and virtually all information stored in other media is not readily available. It must be retrieved by specialists, oftentimes with great difficulty, or printed out by a machine.

The printout approach is the most common and the most heavily criticized. The economics of computer systems make it unattractive to print out reports tailored to the specific needs of each manager and professional. More importantly, it has been almost impossible to get managers and professionals to specify beforehand exactly what their information needs are. As a result, information systems designers have tended to design systems producing reports which meet everybody's needs plus other needs which the designers consider important. Thus, managers and professionals are inundated with tons of machine-generated reports, containing information of marginal relevance to their specific needs.

As the network concept is translated into reality, and as machine-oriented records management systems become more prevalent — systems involving data base management, text management and so on — managers and professionals will be provided with direct access to machine-stored information, whether that information is in the form of data, text, image or voice. Instead of receiving generalized reports, they will be able to specify exactly what they need and obtain it on an ad hoc or regularly scheduled basis. Selective, personalized access to information bases, both internal and external, is the goal of the network concept.

The question, of course, is whether managers and professionals, who were previously unable to specify their information requirements to systems designers, will be able to so specify when they have direct on-line access to machine-stored information. No clear answer is available, but the evidence to date is encouraging. Companies which have developed such access systems observe that initial efforts are not very successful. However, the process is a learning experience, a self-training effort in which early hit-or-miss approaches give way to well-thought-through analyses of requirements. The brokerage field offers powerful testimony to the level of proficiency which managers and professionals can achieve in using machine-stored information.

The alternative is substantially less attractive. The inability of managers and professionals to specify information requirements, the resultant overload in irrelevant information, and the high costs of producing that information have triggered rising interest in the concept of information resource management, in which a member of senior management is appointed as an information czar to address the information overload problem and its attendant costs. As currently envisioned in various circles, the information resource management concept carries with it the implication, expressed or implied, that the overload and irrelevancy problems can be eliminated by having the czar decide who gets what information when and in what form. George Orwell's prediction for 1984 would thus come true.

Improved movement

One category of capabilities offered by modern office technologies, then, is improved access to information. Another is improved movement of information. An enormous imbalance exists in most corporations today in the flow of information. For example, many companies have installed computer-based sales reporting systems, which cost millions of dollars to develop. These systems gather sales information from the field, quickly aggregate it and present it in report form to various levels of sales management for appropriate follow-up. The most sophisticated combination of communication systems and computing power have been employed to get comprehensive sales information into the hands of management as quickly as possible. In the follow-up process, however, when sales managers query their subordinates to obtain explanations for unexpected sales gains or losses, the communications systems support consists of the telephone, with its well-known problems of telephone tag, and the internal mail system, the vagaries of

ABOUT THE CHANGING OFFICE

depends very much on the breadth of the product line involved. Sadly lacking is any serious emphasis on planning, economics, people implications and future directions.

When one contemplates the extraordinary changes which will take place in the office in the years to come and supports the premise that these changes must be managed, two facts stand out. First, the reservoir of trained talent to carry out such a management assignment is not in place nor are there credible experts one can turn to for assistance. Rather, to the extent that it exists, the expertise is in the collective wisdom of the managerial workforce in place, augmented by some research being carried on in the academic community and by information available in trade literature, research journals and vendor material. Until more formal education approaches are available, the most effective strategy is to tap the collective wisdom of today's managers by sharing views and experiences.

Second, the curricula of business schools and universities must be expanded to include education in the management of change — change brought on by exploding technological developments, a workforce with different standards and aspirations and the need to introduce proven line management principles into the management of office operations. Perhaps one unanticipated effect of new developments in the office will be that of forging closer ties between the business and academic communities in joint efforts to make today's curriculum more responsive to tomorrow's office.

which defy the imagination. Thus, the economic return on the multi-million-dollar investment in the sales reporting system is dissipated by the inadequacies of the response system.

If one were to examine a typical manager's day, one would find an inordinate amount of time involved in communication delays. At any given time, a manager has a number of activities under way, each awaiting communication of information — correspondence awaiting a response, proposals awaiting an approval, questions awaiting an answer and so on. The managerial assignment is a continuous mental juggling act, aided by tickler files and similar devices, an ongoing effort to keep track of activities which are in suspense because of delays in the availability of the appropriate piece of information. Some delays, of course, are the result of the deliberateness of the decision-making process. Most, however, are caused by inadequacies in the communications system.

The network approach to the use of advanced office technologies attempts to minimize these delays by utilizing the speed of electronic transmission for as much communication as possible. Thus, the sales reports and the correspondence and messages they trigger all move electronically. The response system is in balance with the gathering system, and the investment in both pays off in better management control.

From the point of view of the manager and the professional, the key word in describing the impact of improved information movement is responsiveness. Managerial monitoring of performance, professional studies and analyses and a variety of other activities which take place within the framework of an on-going business operation are all facilitated by the faster flow of information provided by the network. Of even greater value is the handling of the unexpected, that ultimate test of the manager when business conditions change in the field, and of the professional when confronted with the demand for a special study. The ease with which information can be made available through the network and the speed with which the information can be moved will enhance very greatly one's ability to respond to the unexpected.

Senior management

The essence of the future office is change, change in people, change in machines and change in facilities, and those changes must be managed. They cannot be allowed to come about in haphazard fashion, lest all semblance of control of office operations and office costs be lost. Further, that management effort must be directed by senior management, because three of the changes which affect people will also have a major impact on the base business itself. The first of these is that modern office technologies, properly employed, can help improve office productivity. The second is that the speed-up in communications associated with networks of technologies allows one to consider changes in organization structure. The third is that improved availability and movement of information will impact management processes.

Office productivity

The need to improve productivity in all aspects of business is well-known and, in fact, improving productivity is fast becoming a national crusade. However, productivity is a difficult word to define when applied to office operations. The traditional definition of output divided by input does not work well, because the output of the office cannot be easily specified. Further, defining productivity becomes especially difficult when the term is applied to knowledge workers, managers and professionals whose work is qualitative rather than quantitative.

Instead of wrestling with "productivity" as a corporate goal, perhaps a better term is "operating effectiveness," that the goal is to improve the operating effectiveness of the office and all those who work in it. In that light, senior management now has the unique opportunity to use the introduction of new technologies into the office as a catalyst to help achieve such a goal. By stressing effectiveness as a goal, rather than the traditional goal of office efficiency, the operating effectiveness concept carries with it the connotation that many of the management principles developed for the operating side of the business, and the lessons learned in their application, can be applied to the office.

Operating units have a defined set of objectives to be accomplished. Tasks to be undertaken undergo rigorous examination and evaluation in terms of how well they help achieve the stated objectives. Those tasks which do not need to be performed or that contribute only marginally to accomplishment of goals are removed from the duty list. Only those which contribute to success are performed. Plans developed to carry out the tasks are subjected to the same rigorous examination as is the system for monitoring performance.

Not so in the office. Office personnel

WORKING AT HOME

The prediction that tomorrow's office worker will work at least part-time at home has been discussed at length in books and articles. The network approach to technology supports that method of operation since its underlying premise is that all of the information and technological capabilities available in the downtown office location are equally available wherever one can tie into the network. Further, the benefits to the employee, in terms of avoiding the trauma and costs of rush hour commuting, of being able to work in a time frame which fits one's personal requirements and of being able to concentrate on work without interruption are powerful incentives to pursue the work-at-home idea. In fact, studies to date show a substantial increase in productivity for employees in such programs.

However, the existence of a technological capability and the possibility of benefits accruing from its use are not sufficient incentives to embark on alternate work location programs without examining the consequences in some detail. Companies that have tested such programs, including work-at-home as well as working in various combinations of downtown and suburban locations, verify the benefits from both the company's and the employee's point-of-view.

At the same time, they have identified problem areas which should be recognized and addressed:

- The attitude of the supervisor toward the new work arrangement is a key factor in its success. The belief that "out of sight" means "on the golf course" quickly undermines the employee/supervisor relationship.

lack a clear statement of objectives developed in consonance with a business plan. They have no criteria for screening out unnecessary tasks or for identifying tasks of questionable benefit. Without stated objectives, they have no meaningful way of measuring performance. The office is task-oriented rather than goal-oriented.

Under the umbrella of managing the process of change and using the introduction of new technologies as a catalyst, senior management can institute programs to introduce line management principles into the office. Sets of objectives can be developed against which the *importance* of tasks performed and the way they are performed can be evaluated. Operating effectiveness can be improved by screening out unimportant activities and by coming up with better ways of handling important tasks. The ability to develop systems to measure improvements, qualitative or not, will be greatly enhanced because of the goal-orientation of the office. In such an operating environment and with modern tools at hand, office personnel will join enthusiastically in programs to improve office productivity. (See box.)

Organization structure

The advent of new office technologies brings to senior management the opportunity to improve operating effectiveness. Of even greater importance, modern office technologies can impact the organization structure of the total enterprise. The typical pyramidal organization structure found in business today was developed originally by the military based upon theories of span of control, the number of people an individual could personally supervise in an effective way. If the people to be supervised were a homogeneous group, all in one location, the span of control could be quite large. In the office, the number of people per supervisor in a data entry department is a typical example.

If the people to be supervised represent different disciplines, in different geographic locations and time zones, the span of control is much smaller. That phenomenon has nothing to do with the supervisor's abilities. Rather, it results from communications delays, delays in the time it takes to get feedback from whatever performance reporting system is used, telephone tag, the vagaries of the mail system and so on. The supervisory assignment is essentially the same. It just takes more time to carry it out because of communications delays.

Span of control is one of the factors which determines the height and breadth of the organizational pyramid. The other is information assembly. Operating information enters an organization at the lowest level of the pyramid. In addition to a supervisor's span of control capabilities, the size of that level depends on how much operating information can be gathered in a prescribed time period, aggregated as necessary and communicated up the line to the next organizational level. The process repeats itself at that level and at higher levels, as information from lower levels is aggregated and communicated on up. Eventually, fully aggregated information reaches the top of the pyramid. Some filtering and interpretation may take place along the way, but most of the time involved is in the aggregating and communicating of information.

Modern office technologies incorporated into a network introduce several new factors which bear on this organizational arrangement. By introducing a quantum speed-up in communications flow, networks can reduce substantially the communications delays which are primary factors in determining span of control limits. Concurrently, information available at the lowest level in the organization is available simultaneously at all other levels through the network. These two factors operating in concert permit senior management to re-examine span of control limits and the justification for the number of organizational layers in place. Technology does not tell management how to organize the business. Rather, it offers management the opportunity to consider organizational alternatives not available heretofore.

The economic benefits of eliminating organizational layers and flattening the organizational pyramid can be extraordinarily attractive. The operating benefits can be equally valuable because a lean organization, stripped of overhead no longer needed, can compete more aggressively in the marketplace and respond more quickly to unexpected changes in business conditions. Office personnel working in such an environment will find themselves challenged by the opportunity for personal innovativeness and contributions. Their work experiences will be far different than that of today, where communication delays foster overstaffing and organizational layering. Stifling of initiative and unending frustrations are the burdens which must be carried by anyone who works in such an atmosphere.

- Certain assignments, those with clearly defined tasks requiring minimal group interaction, are good candidates for work at home programs. But many assignments do not have those characteristics and the choice has to be made carefully, lest the charge be leveled of inequitable treatment of employees.
- There are legal implications associated with work-at-home programs like restrictions on working hours and the constraints of local zoning ordinances; insurance considerations involving liability for accidents and damage to equipment; tax, security and safety questions; and a variety of other factors which must be taken into account because today's laws and work rules are based on a central office approach to work location.
- Serious attention has to be paid to formal training for work-at-home employees, their participation in periodic group activities must be encouraged and assurances must be given that they will receive equal consideration with central office employees for career advancement opportunities.
- Attention must also be paid to family considerations. The wife at home, who says she married her husband "for better or for worse but not for lunch," and the wife who admits she works in order to get away from the house are voices that demand to be heard in selecting candidates for a work-at-home program.

Overall, whether working at home, or participating in videoconferences, or responding to one's mail on a tube, human behavior will be affected by new office technologies in diverse ways. Any successful use of the technologies must anticipate and allow for behavioral change.

Management processes

Management processes are also affected by the introduction of modern office technologies. One trend in management processes is participative management. A second, reflected in organizational decentralization and other approaches, is the desire to move decision-making down to the lowest level possible in the organization. Both trends are being slowed by problems with information, and in both cases modern office technologies can provide a significant breakthrough.

The purpose of participative management is to get more people involved in the planning and decision-making process. The key is to keep everyone informed. The information media, unfortunately, are meetings and paper. The meetings have value, but in most cases they are too long and occur too frequently. Further, the mountains of paper produced, covering all aspects of the subject, and the efforts to make sure everyone gets the proper material on time turn a valuable activity into a hassle. Replacing the paper with a computer-based file of information accessible through the network, and substituting various kinds of teleconferencing for many of the meetings can minimize the hassle and maximize the potential of participative management.

Similarly, programs to spread decision-making authority to lower levels in the organization require, first, an assurance that those now being asked to make decisions have the necessary information available to make the decision and second, that there is a control system in place so that senior management can monitor the decisions made and the results obtained in timely fashion. Here again, modern office technologies become a major factor because of the ability to access information through the network to meet both needs.

Thus, managing the changes taking place in the office cannot be relegated to technologists, as happened so often in the past. New developments which affect operating effectiveness, organization structure and management processes impact the base business itself. Managing them is a senior management responsibility. Whether the assignment is given to an individual or a management committee, senior management must be continuously involved in the process and make sure that all plans and programs are developed within the framework of the overall business plan.

Pitfalls and perils

Technology offers a set of tools to help improve operating, organizational and management effectiveness. The challenge is to manage the introduction and use of these tools in a way that maximizes their potential. As with any important challenge, the road to success is filled with pitfalls.

In this paper, the impact of new office technologies on people has been examined by classifying office personnel as either technologists or non-technologists or senior management. Pitfalls can be identified in terms of each. In addition, there are perils in the way the equipment is applied and in the physical characteristics of the machinery itself. Finally, the ultimate peril is that the machines, whose primary purpose is to improve communications, will, in fact, produce exactly the opposite effect. Perhaps if these pitfalls and perils are recognized beforehand, they can be avoided or their effects minimized.

The greatest pitfall among technologists is resistance to technology. This paradox is the root cause for much of the political infighting going on in today's offices and for the power struggles which have sometimes brought progress in the use of new technologies to a virtual standstill. The resistance is not to one's own technologies. Rather it is to other technologies and the way they are encroaching on one's turf.

There is little understanding and even less acceptance in the technological community of the changes taking place in the office, of the convergence of technologies and what that means. The idea that technologies are being integrated, that networks will be the dominant technology of the future and that the independence of data processing, word processing and other technologies will eventually disappear is being fought on many levels, even into senior management ranks.

The convergence of technologies can be viewed as an opportunity or a threat. If the latter view prevails, and technologists resist change, the opportunities offered by modern office technologies will be lost. There is a crying need for technological leadership in the office, but that need will not be met if the resistance to change prevalent among today's technologists is not overcome.

The greatest pitfall among non-technologists is also resistance to technology, but the reasons for that resistance are quite different. Lack of understanding is a factor, fear of looking bad is another, perhaps distaste for screens, keyboards and other mechanical devices is a third. But the overriding reason why non-technologists in the managerial and professional ranks resist technology is the image they have developed over the years about data processing, word processing, telecommunications and many other office technologies. That image is one of rigidity, structure, and lack of responsiveness to changing business needs. Whether that image is deserved or not, it exists and has become the primary stumbling block in efforts to introduce machines into the offices of non-technologists. Nowhere is this phenomenon exemplified more dramatically than in today's office, where managers and professionals turn down use of computer terminals offered by the data processing department and then go out and purchase personal computers. The latter may offer fewer capabilities, but they come unfettered by the bureaucracy of the technologists.

If full advantage is to be taken of the capabilities of modern office technologies, then this image must be changed. Technologists must learn to design systems and set up their machines in a manner which fosters flexibility and responsiveness. Only then will non-technologists in the managerial and professional ranks be willing to accept with enthusiasm some of the new offerings.

The greatest pitfall facing senior management in the future office is lack of willingness to take charge, to step in and apply time-tested principles of management to the office. There is evidence that some senior managers recognize this and are taking positive action, oftentimes under the banner of productivity improvement programs, to home in on managing the changes taking place in the office. Sad to say, in most cases the reverse is true, and responsibility is being relegated to technologists. Whenever one hears that the senior data processing executive or some other technologist has been assigned responsibility for office of the future programs, the question has to be asked: Was the individual chosen based on managerial proficiency or on technological expertise? If the latter, then the effort will be subject to the same charges that were leveled at data processing in the 60s and 70s — economically unmanageable, wrapped up in technology and outside the mainstream of the business.

There are pitfalls, then, in the efforts to utilize modern office technologies most effectively, involving technologists, non-technologists and senior management. There are also pitfalls in the way in which the machines are used. The traditional approach to the design of systems which use machines is to develop standard procedures, compartmentalize tasks and organize work flow to maximize the efficiency of the machine. Technology's image of rigidity and structure stems from this approach.

While acceptable in the efforts to mechanize routine tasks, standardization and compartmentalization are not effective in the use of machines in the performance of intellectual tasks. Here, the emphasis is on providing an array of capabilities to managers and professionals for them to use as they see fit. However, tradition dies hard, and systems designers still attempt to structure machine use, and to predetermine who should use the machines, how they should be used and so on. In many cases, the design effort includes proposals to structure jobs around machines, as was done so often in the past.

If modern office technologies are to fulfill their roles as tools to help managers and professionals operate more effectively, then the decisions about who uses them and how they are used must be made by the users themselves rather than the system designers. Further, technology should not be raised beyond the status of a tool. Jobs should not be designed around machines. Rather, machine systems should be designed so that jobs can be carried out more effectively.

There are also pitfalls with the machines themselves. For example, the terminal with its keyboard and screen is the interface through which today's and tomorrow's office personnel will access the network and all the technologies tied to the network. The physical form of the terminal will undoubtedly change over time, but its primary functions of entering, manipulating and displaying information will remain the same. In view of the importance of terminals in the whole field of office technology, serious consideration must be given to the complaints that extensive use of terminals can cause fatigue, eye irritation, stress, backaches and other physical ailments.

Unfortunately, these complaints have not been taken seriously. They are being dismissed as symptoms of job fears and resistance to change. Further, those studies which have been made of the physical effects of working with terminals have been less than precise in pinpointing problem areas. But anyone associated with the field knows that excessive use of terminals can have undesirable side effects. Further, a visit to a business equipment show will provide immediate evidence of the differences among machines in terms of ease of viewing, legibility, contrast and so on. These differences illustrate that vendors are trying various approaches to counteract the adverse side effects of terminal use. They also show quite vividly that much remains to be done.

European countries have already instituted work rules designed to provide relief from the physical problems associated with excessive terminal use. Rather than wait for government intervention, designers of new office systems should incorporate similar work rules into design strategies so that the benefits of terminal usage can be enjoyed without concern for possible adverse physical side effects.

The last peril is more serious and far-reaching than all the others. It is exemplified in the use of modern office technologies, but it also has ramifications in all aspects of life today and tomorrow. The peril is that as human beings communicate more and more through machines and with machines, they will lose their ability to communicate with one another. One of the prized skills in any human organization is the ability to communicate effectively. It is not easy because it requires the ability to listen to the other person, to put oneself in his or her place, to interpret body language and other indications of reaction and to present one's ideas in a manner which is persuasive and effective.

Some people seem to possess that talent naturally, but many do not. In most corporations, workshops to develop communications skills are an important part of managerial and professional training. The difficulty in acquiring those skills and putting them into practice is the root cause for many of the problems encountered in any kind of cooperative endeavor.

In a world where the use of terminals becomes more common and one spends a growing portion of one's work day communicating through a terminal rather than face to face with other human beings, there is a very great danger that communication skills will atrophy. The phenomenon can already be observed at video arcades, among personal computer buffs, in programming departments and throughout other high technology entities. Eventually, the ranks of those who prefer to talk to machines rather than to people may grow to the point that group endeavors, which are a key element of business operations, will become almost impossible to organize and manage. Teamwork, participative management and other group-oriented practices will suffer greatly. (See box.)

This machine versus human communications phenomenon is not confined to the office but it is of vital concern to anyone who is attempting to manage the introduction and use of advanced technologies rather than letting them come on the scene willy-nilly. Technologies which augment the intellectual activities of human beings affect human behavior. That fact should be a cornerstone in developing plans for the future office, in order to ensure that the effects are not adverse. The objective should be to use machines to augment communications skills rather than diminish them.

Is it worth it?

The introduction of advanced technologies into the office will have a major impact on office personnel. Technologies will find themselves lifted from the security of a single technology into a world of networks. Non-technologists will discover that responsibility for making optimal use of an expanded array of new capabilities is theirs and not that of specialists. Senior managers will be faced with managing changes in organizational strategies and methods of management. All of this will be accompanied by perils of substantial magnitude and myriad pitfalls along the way.

In such an environment, one has to ask the question, is it worth it? Why disrupt office operations, undergo the traumas of change, take the chance of alienating people and not only rock the boat, but perhaps sink it? What are the benefits? The answer is twofold. The first is that the changes are going to happen, like it or not. A technological tiger is loose and cannot be contained. The potential of the marketplace and the forces of competition will result in the introduction of a bewildering array of new machines with constantly expanding capabilities. One can attempt to manage these technologies in an intelligent way, or one can let them pour in haphazardly. But there is no holding back the tide.

The second answer is that modern office technologies, properly introduced and managed, can provide extraordinary benefits. They can speed up access to information and the movement of information. They can take over routine office tasks, leaving office personnel with the challenge of handling more intellectually stimulating tasks. They can provide managers and professionals with an array of capabilities to help improve productivity and operating efficiency. They can help improve the economic viability of the office and its contribution to the bottom line.

Of even greater importance, modern office technologies can help expand human potential. Their ultimate value is not just in doing things more efficiently. Rather, it is in helping office personnel perform better in their chosen lines of endeavor, helping them be better planners or analysts or managers. Looked at in this light, the office of the future is a place of intellectual stimulation, of personal growth, of excitement and of challenge. Its key ingredients are people whose skills have been augmented by a powerful array of new tools. Its success will depend on how well those people cope with and manage the process of change. MOP

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THE MEANS, NOT THE END

Productivity

BY MICHAEL HAMMER AND JAY S. KUNIN

"Productivity" is currently the most popular word in the office automation (OA) lexicon. Not a week goes by without an announcement of some device, system, technique or concept guaranteed to improve your productivity or that of your office, secretary, manager or even your entire corporation.

Productivity is a buzzword that has no inherent meaning — it means whatever the user wants it to mean. Does increasing the number of documents prepared by an office improve that office's productivity? Does the use of electronic mail really enhance "managerial" productivity? If so, how?

The traditional approach to office automation focuses on the basic tasks customarily associated with office work: typing, communicating, filing, retrieving information and so on. OA technology is used to make these tasks more efficient and accurate, and productivity is measured by the volume of these tasks performed.

However, there is a fundamental flaw in this viewpoint: it mistakes means for ends, artifacts for essentials. It looks at office work in a vacuum, without any business context, and assumes that an enhanced capability to perform rudimentary office tasks is ipso facto improved productivity.

I believe, however, that office work is a misleading concept, its automation is not a worthwhile objective and the term productivity is fundamentally inappropriate in most office environments. Office tasks are not ends in themselves; they are only means to achieve business objectives. Increasing the efficiency with which these tasks are performed is only of interest if it improves the business function and not just the information handling capabilities.

Office automation, narrowly interpreted, is only one component of a much larger and more important enterprise: the improvement of organizational performance. The real objective of OA is not the installation of automated systems into an office environment, but the enhancement of the business objectives of the organization, using new technology only when and where it is appropriate.

An office exists to implement some business functions that can be expressed in terms of the goals and needs of the larger organization. If it does not function as such, the office is a candidate for elimination, not for automation! In implementing an office system, the first question must be, "What is the nature of the business problems this office is facing?"

What are the implications of this functional approach for the elusive definition of office productivity? First, the current preoccupation with managerial and professional productivity is a search for the answer to the wrong question. Besides the fact that no one has devised a satisfactory way to measure this concept, the very notion of productivity is misleading in a managerial context. As opposed to a production line worker, a manager does not have tangible output with intrinsic economic value. Two memos are not necessarily twice as valuable as one memo. Further, there is no particular reason to believe that rudimentary tools such as electronic mail will have any bearing on an individual's real productivity, even when these tools can be shown to save a certain number of minutes of that individual's time. Issues of time recapture, working styles and technological tools that encourage their own overuse determine the real impact of this kind of automation.

Second, this functional perspective has consequences for planning and implementation. The principal goal of the OA planning effort then becomes not the establishment of a timetable by which the latest technology can be introduced into the company, but a strategy by which office systems can contribute to the improved operation of the company's business activities. Planning and implementing office automation will then be based upon a thorough understanding of the characteristics, activities and needs of the organization.

Every office in the organization is unique and must satisfy a specific set of requirements in a special set of circumstances. As a result, no approach, particularly if based on the least common denominator of office work — word processing, communications and so on — will be appropriate for all offices. Nor is there much to be gained from aggregate analytic and planning techniques based on an assumption that benefits will accrue to broad classes of office personnel as a result of using generic office tools.

Many different constituencies within the company must be involved in the planning process. The company will benefit from these perspectives and expertise and will also ensure that these groups feel they have contributed to the plan and therefore have some stake in its successful realization. Office automation is not an activity that can be imposed on an unwilling organization: both line management and staff must participate.

It is also necessary to prove the benefits of office automation on a relatively small scale before attempting to get senior management to commit to a grand plan. "Increased availability of information" is too vague and insubstantial a reason to convince management of the validity of the OA concept and the virtue of investing in it. Senior managers are understandably skeptical about committing to every new fad that afflicts the information systems field and will demand prior demonstration of validity and practicality.

The key initial step in the development of an office systems plan is therefore the implementation of one or more pilot studies (sometimes known as model offices). A pilot is not an experimental environment in which new and unfamiliar technologies are tested. Rather, it is a prototype of the larger scale automation effort that is to be applied throughout the firm.

The pilot begins with the selection of a unit to serve as the site of an effective demonstration of the benefits OA can bring to the company. A study is then made of this unit to identify its real needs and to determine how automation can address them. This study is then followed by a small-scale implementation effort to demonstrate the benefits can, in fact, be realized and to assess implementation costs that might actually be incurred in a production environment.

The results of this study provide the basic information needed for full-scale planning: an understanding of business operations, an identification of the objectives for OA techniques that can be applied in addressing the needs of business units and an appreciation for how and to what extent objectives can be realized.

A secondary benefit of the pilot/prototype approach is that a successful initial effort can have substantial impact throughout the company. It can raise the credibility of the OA group, especially in situations where the data processing organization has a checkered track record and reputation. When other units see the

success the pilot organization has had with its system, they will begin to agitate for their own installations. This will greatly simplify the problem of disseminating an understanding of and an enthusiasm for OA within the firm.

The concepts summarized here are not speculative or controversial. They have been demonstrated in practice by many firms that understand the capabilities of office systems technology, but recognize its limitations as well. With an emphasis on business mission and function and an involvement of the user group, office automation and productivity can mean major improvements in the ways offices achieve their objectives.# OA

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Electronic Management

Wonderous new computerized tools already moving into executive suites

U.S. business has turned to electronic processing of office functions to increase productivity. In 1982 alone, makers of office systems and equipment project $17 billion in sales, and the industry has sustained a growth rate of almost 30% during the last three years.

Electronic typewriters, word processors, and display terminals are replacing such traditional tools as the typewriter, mail pouch and file cabinet. The need for putting information on paper is diminishing, due to electronic alternatives such as video display terminals (VDTs) and voice mail and message systems.

For managers, the changes will not effect what they do as much as how they do it. Executive terminals with computational, scheduling, graphics and modeling capabilities will help professionals raise their productivity.

Execunaut or Not?

Last year, the term "execunaut" was coined to describe senior executives who make utmost use of available technology to enhance their decision making capabilities; who actively seek out and develop ways to make themselves and their subordinates more effective, using the new electronic hardware and software that is becoming more and more available.

Some of these executives virtually plug into their management systems the way Appollo crewmen plug into their life support systems.

Others, who would almost certainly object to being called execunauts, maintain a clean desk in a traditional executive office environment, letting subordinates handle the hardware. But their information has been developed, analyzed, compared and prepared for them in easily readable form—using computers, high speed copier-duplicators and the host of other electronic office machines that have revolutionized the gathering, processing, utilization and storage of management information in less than a generation.

Either way, they represent the leading edge in management technology.

The bare desk, with no electronic presence other than a telephone and a dictating machine, is still considered the ultimate in executive style in many companies, but the work station (new name for a computer terminal with a keyboard and video display screen) will eventually be as ubiquitous as the telephone (possibly even replacing it), and the executive who can't handle a keyboard will be as rare as the one who can't read a balance sheet.

New Era Management Tools

The management tools of the pre-electronics era were primarily intellectual ones. A senior manager's main job always has been to analyze situations, review options and make decisions based on this analysis and review. Thus, management training has always concentrated on increasing the manager's intellectual capacities, on teaching him/her to think like an executive. Management "hardware" was limited to legal pads, status pen and pencil sets, and an inobtrusively designed dictation machine.

No more. Now executives have available off-the-shelf hardware and software tools that actually extend intellectual capabilities. They cannot think for the executive, but they can provide more, better and timelier information that can make perceptions more accurate, deliberations more incisive and decisions more correct.

Computers—All the new management information and management support systems currently installed or being installed in business and industry are computer-based and/or computer-controlled. The world of computers has changed radically within the last five years, but the shape of the computer industry as it will effect non-technical computer users over the next few years has defined itself rather clearly.

What used to be called "mainframe" computers—the ones that filled entire glass enclosed and rigidly climate controlled rooms—are now labeled "super-computers," and they are super indeed in processing and storage power and in cost. These huge computers are so sophisticated, and so expensive, that they are still mysteries to most executive computer users.

What used to be called "mini-computers" are starting to take over the job of "central processor" that the "mainframes" have traditionally filled at corporate computer centers. And the so-

called "microcomputers," the units originally developed to become "personal computers," are being offered in configurations as powerful in function as the old minis. The functional parameters of the computer have improved dramatically from a user's point of view, in that they have grown more efficient at the same time that they have gotten more compact and less expensive.

But the average executive user needs no more advanced knowledge of computer technology than does the airline passenger need to know the laws of aerodynamics.

These are the basic facts an executive needs to know about his computer: 1. How much processing power does it have, expressed in bytes of internal memory? (Minimum practical size for management applications seems to be around 32,000 bytes of internal memory.) 2. How much interactive external storage capacity does the system offer? (Is it sufficient to hold all the information records that must be stored and processed for a specific application?) 3. Are the input and output mechanisms of the system (usually keyboard and video display and/or hard copy printer) sufficient to feed into and extract from the system the information needed in the format that best suits his needs? 4. Is there affordable software that allows the computer to handle information processing requirements?

Terminals—Executives today must decide whether or not they want a computer terminal at their desks, either one that links into a central processor or perhaps a personal computer. (Most personal computers big enough for office use can be used as terminals, as well.)

This often becomes a matter of executive style. Some senior executives dislike an electronic presence in their offices, either for reasons of decor or because they feel uncomfortable with computers.

Executive resistance to terminals-at-desks is easing, however, and most serious thinkers in the field of management theory now assume that all white collar, managerial and executive employees at medium to large size companies will eventually have their own desktop terminals. Many, in fact, will have "electronic work stations" instead of desks.

In addition to word processing, which is primarily intended for secretaries, work station station terminals can be used for electronic mail (sending memos, etc., to other terminals), for electronic calendaring (which can help arrange meetings by a computer scan of times when all participants are available), for retrieving data in central computer storage and plotting that data into graphs and charts for analysis and display, and for electronic filing and retrieval of documentary material.

Paul A. Strassman, vice president, Information Products Group, Xerox, told a meeting of senior research executives last year that the projected population of electronic work stations by 1990 will be in the range of twenty-five to thirty million, up from some three million in 1981.

Software—Computers are just worthless boxes of electronic circuitry without the software which tells them what to do and how to do it. One of the great strengths behind the amazing growth of Tandy/Radio Shack's TRS-80 series of personal size computers is that the company has encouraged outside software firms to develop applications software for its computers. The company actually prints a huge directory of firms offering software for use with all models of the TRS-80. Much of this software is directly competitive with packages that Radio Shack sells, but Tandy was smart enough to realize from the beginning that lack of use opportunities would limit sales of computers and computer accessories and supplies.

There has been resistance to this approach by what had been known as the "mainframe manufacturers," but more and more of them are authorizing non-proprietary software packages for use on their systems. They still develop and sell their own standard software packages, of course.

The result is more good software for many applications than would have been imagined even two years ago. The software is available, both as thick paper documents (the instructions of which must be handcoded into the computer), and as tape cassettes and disks, on which the instructions to run the computer are recorded much like music on audio tapes and records and which are "played" into the computer's memory.

How important software is to the executive, as an information user, will be described in the profiles that follow.

Teleconferencing—This application has been so long in coming that many people don't believe in it anymore. But believe! Big companies and government agencies are installing video teleconference rooms in offices at strategic locations, and telephone conference hookups have been used for years (American Airlines has a telephone conference hotline, for instance, to help solve such problems as schedules messed up by weather conditions, etc.). The high cost of energy and other burgeoning travel expenses have begun to make the costs of teleconferences feasible for many types of inter-regional meetings.

By the turn-of-the-century (and perhaps before, now that Ma Bell's Western Electric manufacturing division can adopt a more aggressive marketing posture due to the AT&T settlement) person-to-person video meetings will have become the norm. The video display tube of your computer terminal also will be fitted with a camera. You will be able to look associates in the eye from across the country as easily as if you were across the room.

Graphics—Computers have long been an ideal tool for assembling masses of information and then refining the information by analyzing, comparing and evaluating it, even using this upgraded computer information to make educated projections of probabilities based on available data.

Recent advances in computer graphics, including color graphics, have made computers an increasingly valuable tool for this purpose, allowing the executive to break information down and reassemble it in a variety of graphic formats that can add new meaning and impact to the analysis and evaluation procedure—and provide greater impact for final presentations at the same time.

Data Communications—This is the rapidly advancing art of linking the full spectrum of information processing tools together, either by coaxial cable or over telephone lines, to enable users to process and communicate information on a shared circuit basis with other information processors and/or communicators.

Almost every type of office equipment, even copiers and dictating machines, theoretically can be linked into completely integrated office and information management systems using advanced network formats. Companies of all sizes are presently installing such networks, or are planning for them.

The companies doing so are largely setting up their own networks using off-the-shelf hardware and self-developed

software. Only recently have the computer manufacturers begun to deliver on their initial promises of elegantly architectured networks for information processing systems.

Datapoint Corporation recently began offering systems capabilities utilizing both its ARC coaxial cable network and an advanced digital PBX system it calls ISX. It says its first combined system installation is being installed now, and will provide seven fully compatible office functions, communicating with each other by means of:

- Conventional twisted pair building wiring.
- ARC coaxial cable networks.
- Optical and microwave communication links.
- Common carrier connections.

IBM, Xerox, Data General and Digital Equipment Co. are among the leading firms that offer varying degrees of advanced integrated information processing capabilities.

Traditional Office Equipment—Some traditional office equipment is not being replaced, but is being upgraded and controlled by "microprocessors," very small computers dedicated to just one person. This is the case with copiers and dictating machines, for instance.

Copiers become more sophisticated each model year, to the point where they are now faster, deliver better quality copies and are cheaper than they used to be (for comparable quality). They can even diagnose their own malfunctions and give the operator instructions as to how to fix them.

Dictation machines are smaller, easier to use and, again, computer controlled. Central dictation systems have been developed that allow the executive to dictate, by phone, from any location in the world with the assurance that the dictated material will be typed out as soon as the secretary or a pool typist can get to it.

Microfilm equipment, far from being replaced by computer storage, has been computerized itself, and is being used to augment the capabilities of computer storage systems. Eastman Kodak, 3M and other leading firms in this field introduce new computerized microfilm technology almost every month.

Furniture—Some thinkers look for a change in office furniture design within the next generation. Telephones will be built into computer terminals (they are already being built into consumer television sets by Zenith), and terminals will be built into desks. Norman Weizer, a computer specialist with Arthur D. Little, Inc., Cambridge, Massachusetts, sees a variety of executive work stations coming within 10 years: "Decision makers may only want only a basic terminal to provide them with essential information from the central database. Executives at lower levels who are writing reports for top management will want more elaborate systems to produce the detailed information required of them."

Some Cases in Point:

The best way to understand the present state of management information and support systems is to examine how some typical firms are using them.

U.S. Trust's Executive Information Center—Old money and new technology meet daily at 45 Wall Street, in the executive offices of United States Trust Company of New York.

A New York state chartered bank and trust company with assets of over $2 billion, U.S. Trust has managed some of the largest estates and trusts in America since it was founded nearly 130 years ago. Now it is managing them electronically. The bank has used computers for years for the traditional general accounting, bookkeeping and record storage applications normal to a large and successful financial institution. But computer power is being brought right into the executive suite through a unique combination of executive software and strategically situated color graphics terminals.

Joel Abramowitz, senior vice president of U.S. Trust, is an economist by education and a computer expert by career circumstance. Two years ago, he and associates from his firm attended a seminar on executive information software given by IBM for some of its larger customers. The seminar made them realize that much of the information routinely generated and stored in their computer operations would be more valuable if it could be accessed as needed by non-computer managers to generate custom reports and used for general review and analysis, management model building, even in building a separate accounts file for each manager.

Already enjoying a fairly well automated office at the clerical level (word processing, etc.), U.S. Trust elected to install what it calls its "information center" at the vice presidential level, making it true "management technology," rather than just "office automation," according to Abramowitz.

Peter C. Arrighetti, vice president and controller of the bank's Assets Management Group, worked closely with Lois Kotel, project manager for the information center, to set up customized management software based on ADRS II (A Departmental Reporting System), and other software packages from IBM. Arrighetti worked "hands on" at the IBM model 3279 color display terminal located in his department until he was sure the system could give managers the information they needed in whatever form they might request (even as a series of color graphic charts, if necessary). Now he is content to let assistants access the system on his behalf and he encourages managers and their staffs to use it freely.

Rodney I. Woods, senior vice president, director of Marketing, notes that the information center provides information that allows both line and staff officers of the bank to follow business more closely on a daily basis. He says, "The information center has put us in a position where we can project trends rather than react to them. And we're not stuck with any one format. We can call out as much detailed information as necessary, within account security constraints, to review, analyze and solve problems on an individual basis."

The information center is so new that executives don't yet all have their own terminals. At the moment, they use centrally located color graphics terminals. But as use grows, the necessity for a terminal at most desks is foreseen.

Wired-in executive at Arthur D. Young—Carl D. Liggio, senior partner and corporate general counsel for Arthur D. Young, the national accounting and management consulting firm, is a true executaut. He uses a telephone headset in his office to free his hands for his computer keyboard. He accesses his computer files as he talks with clients, associates and subordinates. He once microfilmed some 120,000 pages of documents and work

papers on a single case and reviewed them with a portable microfiche reader as he flew back and forth between New York and San Francisco. As he says, "I like to be prepared."

Each of the seven lawyers on his staff has his own terminal and keyboard, accessing a Micom minicomputer which maintains over 3,000 active files on matters on which his staff advises the firm. He says, "Some of these files are cross-referenced under fifteen or twenty different sub-topics. Maintaining a manual system for handling our workload would be out of the question."

He is installing an Apple personal computer in his home that will communicate with his Micom office central processor. The home computer as an extension of the office is a natural trend, he believes. Liggio is sold on executive computer power: "It has increased my productivity and my efficiency, and it has cut down substantially on our departmental potential for errors."

Charting Sales at Rorer—William H. Rorer, Inc., Fort Washington, Pennsylvania, has installed an information center capability for its ethical pharmaceutical business that is similar in concept to the one described at U.S. Trust. However, it is used primarily to generate marketing reports. Every facet of Rorer's business (product brands, competitive products, major accounts, wholesale accounts) is tracked by computer, and this data is regularly reviewed and "massaged" by Rorer executives, who compare both regular tabular report material and the same data provided in contrasting chart forms (bar charts, pie charts, surface charts, etc.).

"The charts drive home our real position with each product and in each market much more vividly than tabular material can do," says Edward T. Croke, Jr., director of trade sales for Rorer. "In fact, we have found this format so useful that before we make our annual business review visit to each major account, we actually prepare computer printouts of all this material for each client employee in the review meetings. We find that it helps both us and the customer understand our mutual sales results for the previous year and projected sales goals for the coming year. We reach agreements much faster, and it already has helped improve our sales."

Credits: Paul Neuman, former business editor and financial columnist for *The Cincinnati Post*, writes extensively on the subject of office technology. This article was written and edited on a TRS-80 Model II computer using SCRIPSIT word processing software. Neuman reports that he also does budgets and financial model building on his computer using VISICALC software, and manages his database using PROFILE software, all from Radio Shack.

Telecommunications/ transportation substitution and energy conservation

Part 1

Kenneth L. Kraemer

The substitution of telecommunications for transportation is held to have major potential for increasing energy conservation within the USA, other developed nations, and even developing nations. This article is the first of a two-part re-examination of the substitution hypothesis based on research and experience of the past decade. This part examines the theoretical potential of telecommunications–transportation substitution for energy conservation, and reviews recent research both on public attitudes towards substitution of telecommunications for travel and on the operational experience with substitution experiments in organizations. Part 2, which appears in the June 1982 issue of *Telecommunications Policy*, examines the major factors which influence whether individuals and institutions will in fact choose telecommunications over travel, and then discusses government policy which could facilitate telecommunications substitution for travel.

Keywords: Telecommunications; Transportation; Energy

The USA, as well as other developed Western countries, is increasingly characterized as an 'information society'[1] in which from 40 to 50% of the workforce is engaged in storage, transfer, or manipulation of data in 'information industries' such as banking, finance, insurance, education, the media, and government.[2] Many of the workers in these information industries travel daily to and from business centres, often in centralized business districts, to interact with other workers and with some communication or storage system, such as a computer, the mail, or a filing system. Many workers also travel from one city to another to conduct 'business meetings' (conferences, meetings, seminars) as part of their business, professional, or educational activities.

Many of the jobs and many of the business meetings do not *inherently* require face-to-face interaction or the performance of physical services necessitating a common physical location. Moreover, advances in information and communications technology provide the capability of substituting various modes of teleconferencing (computer conferencing, telephone conferencing, video conferencing) for intercity travel, and various modes of teleworking (remote computer terminals, word processing stations, teleconferencing, telecommunications-based neighbourhood work centres) for intracity travel, thereby offering the potential for substantial reductions in unnecessary face-to-face contact. Such reductions in travel, achieved throughout the information industries or some proportion thereof, could in turn have major potential for energy conservation[3] within the USA, other developed nations, and even developing nations.[4]

This highly intriguing argument has been the subject of major national and international policy discussions during the past decade.[5] It also has been the subject of technology assessments and other studies of the potential of telecommunications–transportation substitution for increasing energy conservation, and of numerous experiments with telecon-

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[1] D. Bell, 'Communications technology – for better or for worse', *Harvard Business Review*, May–June 1979, pp 20–42; S. Nora, and A. Minc, *The Computerization of Society*, MIT Press, Cambridge, MA, 1980.

[2] M.U. Porat, *The Information Economy: Definition and Measurement*, US Department of Commerce, Washington, DC, 1977.

[3] 'Energy conservation' refers to energy savings resulting from greater efficiency or direct reductions in energy usage.

[4] The usual argument for substitution of telecommunications for transportation goes beyond energy conservation in the case of developing countries. The notion is that the movement of information rather than people provides a way in which developing countries, which have not yet made extensive transportation investments, can simultaneously reduce the need for energy, materials, and capital-intensive transportation systems (R.C. Harkness, and J.T. Standal, *Telecommunications Alternatives to Transportation: A Contribution to Sustainable Economic and Social Interactions*, Stanford Research Institute, Menlo Park, CA, 1976). It rests upon the critical assumption that as developing countries modernize, their workforce will undergo dramatic growth in the information sector similar to that which is occurring in developed countries, thereby creating greater demands for business travel and commuting. This assumption has not been critically examined or supported by empirical study as yet.

[5] See, for example, the final report of the National Transportation Policy Study Commission, *National Transportation Policies Through the Year 2000*, ferencing and teleworking in the USA, Western Europe, Japan, and Australia. Discussions, studies, and experiments carried out in the early 1970s were largely inconclusive. While they tended to demonstrate that there was theoretical potential for energy conservation through the substitution of telecommunications for transportation, they also indicated that, in reality, individual attitudes, limitations of the technology, organizational and governmental policy, the structure of cities, and cost factors operated against achieving the potential in the short term.

The purpose of this two-part article, prepared nearly ten years after these earlier discussions, studies, and experiments were started, is threefold:

- To re-examine the theoretical potential of telecommunications–transportation substitution for energy conservation.[6]
- To review recent research both on public attitudes towards substitution of telecommunications for travel and on the operational experience with substitution experiments in organizations.
- To outline the factors influencing substitution, and the public policy instruments that might be useful for increasing the likelihood that the potential of telecommunications substitution for energy conservation might be achieved.

Although reference is occasionally made to studies in other countries, the primary focus of this article is on developments, research, experience, and policy in the USA.

Methodology

This article is an original synthesis based on existing research and publications on telecommunications–transportation substitution. The major methods used in performing the study were: library search and computerized file search at the National Technical Information Service (NTIS) and the Science Information Exchange (SIE) for recent published work and ongoing research; collection and review of all published works; systematic evaluation of published works; and synthesis of findings from existing research.[7] Data were also collected on organizational experiments with teleworking. Telephone interviews were conducted with business and governmental organizations currently experimenting with various forms of telework, mainly involving computer programmers and word processing operators. The purpose was to gain preliminary information on the operational experience with these efforts so there would be some data roughly comparable to data on teleconferencing. Although by no means comprehensive, nor representative of the range of such experiments, the telephone interviews revealed that almost none of the experiments are being conducted in a systematic fashion that would yield useful results.

Telephone interviews and personal interviews were also conducted with federal, state, and local government policy makers to discuss existing and potential policy mechanisms for encouraging substitution of telecommunications for transportation. The literature on diffusion of innovations was reviewed for general policy guidance with regard to the conduct of demonstrations and experiments with new telecommunications technologies, the promotion of greater telecommunications technology use, and the introduction of new telecommunications technologies into organizations.

Washington, DC, 1979: Richard M. Obermann, Marcel J.Zobrah and Robert S. Hentz, *Initiatives for Conserving Transportation Energy Through Telecommunications*, The MITRE Corporation, McLean, VA, 1980.

[6]Substitution of telecommunications for travel will have other impacts, such as those on working life, urban structure and form, and the transportation industry. These are not examined here except as they relate to energy conservation.

[7]The literature search revealed several interesting findings about the state of research in the field. First, the search of NTIS files revealed nearly all the important works on the telecommunications–transportation question, and the search of SIE files revealed nothing – there are currently no ongoing studies in the SIE files. While this does not mean that there are no studies ongoing, it does suggest that they must be few because the SIE files usually are an excellent source of information about research in progress. This is both an advantage and a limitation for this survey article. The advantage, confirmed by letters from other researchers in the field, is that the database for the article is indeed comprehensive. The disadvantage is that most, though not all, of the studies were conducted during the mid to late 1970s. Thus, some of the findings might be out of date. This is essentially true of the theoretical studies of potential energy savings from the substitution of tele-

Potential for energy conservation

Telecommunications technologies of interest

There is an impressive array of telecommunications technologies and services rapidly becoming available in the USA and other Western countries (Table 1). The specific technologies of interest in the telecommunications–transportation question vary depending upon whether the object is to substitute telecommunications for meetings in person or for commuting to work and shopping. Technologies for the former purpose involve various modes of teleconferencing, whereas the latter involve various modes of office automation (supporting work at dispersed locations in satellite business centres, neighbourhood work centres, or the home) and teleshopping (shopping from home via telecommunications). The two categories are not without overlap. Many of the technologies which can be used as alternatives to meetings in person also can be used to facilitate teleworking and teleshopping.[8]

Today, there are three basic electronic alternatives to meeting in person: video, computer, and audio teleconferencing. The essential differences among these three media are the differences among visual, typewritten, and voice communication. These fundamental characteristics are not likely to change in the near future, but new capabilities will almost certainly be added which will create hybrid media between the categories. Moreover, the media probably will become more accessible as public teleconferencing services are expanded.[9] The alternatives to paper-based communication and information handling in office work are many and diverse, and can all be classed under the heading of office automation. Each of these four media – video, computer, and audio teleconferencing, and office automation – is shown in Table 2 and briefly described below.

Table 1. Classification of telecommunications technologies.

Communications	Form of signal	Established services	New services
Person-to-person	Simple code signal	Radio paging	Development of paging devices
	Voice	Standard telephone service, mobile radio and radiotelephone services	Audio teleconferencing, including loudspeaking telephone (eg speakerphone) and multipoint telephone conferencing.
	Moving picture visual	–	Videotelephone (eg Picturephone®), video teleconferencing.
	Still image visual	Facsimile	Slow-scan video (eg for conference graphics), facsimile.
	Text	Telex/TWX	Computer message/keyboard teleconferencing systems, interconnection of word processing typewriters.
Person-to-machine	Alphanumeric (text)	Data links from teletype or VDU terminals to multi-access computers	Extensive use of computers for routine office automation including text editing, information storage and retrieval, etc.
	Computer graphics	–	
	Various	–	Telemetering and telecontrol or remote control of machines meter reading etc
Machine-to-machine	Digital	Data links	Development of data networks

Source: R.C Harkness, *Technology Assessment of Telecommunications/Transportation Interactions*, Vol 1, Stanford Research Institute, Menlo Park, CA, 1977, Table 3, p 40.

Table 2. Telecommunication technologies usable as substitutes for activities involving transportation.

Possible substitutes for face-to-face meetings	Possible substitutes for paper-based communication and information handling	
Audio or audio-plus-graphics teleconference systems (narrowband)	Computer message systems (including computer conferencing and electronic mail)	Comprehensive office automation/communication systems
Audiovisual teleconferencing systems may include graphics capabilities (wideband)		Computer-based information systems, including document storage and retrieval Facsimile

communications for transportation, since transportation energy usage has declined in the face of rising prices. Nevertheless, the studies reported herein are the best currently available. The problem of dated material is much less severe for studies of attitudes toward substitution of telecommunications for transportation and studies of operational experiments with telecommunications technologies. While some change has undoubtedly occurred, it probably has not been great because the basic social and technological conditions affecting user attitudes have not changed very much. Further explanation of this point is provided in Part 2.

The second finding about the state of research is that there are only a few researchers working in the field, and they are highly interconnected. While this is advantageous from many standpoints, it also introduces potential problems of bias from uncritical acceptance of assumptions, data, and forecasts. As one reviewer commented, 'the predictions about telecommunications technology and about telecommunications–transportation substitution are notoriously inaccurate, and this fact should be pointed out in the article'. Our own view is that, on balance, the better researchers have made impressive achievements given the state of current knowledge.

[9]Teleshopping is not examined in this article due to the lack of empirical studies.

[10]R. Johansen, J. Vallee, and K. Spangler, *Electronic Meetings: Technical Alternatives and Social Choices*, Addison-Wesley, Reading, MA, 1979.

[11]AT&T's Picturephone® Meeting Service currently permits video conferencing among four sites at a time, but only two groups can communicate directly with one another simultaneously: the other two can see and listen in and come up on the screen when another group goes off-line. PMS currently operates among 12 cities (New York, Pittsburgh, Boston, Philadelphia, Washington, DC, Atlanta, Detroit, Chicago, Dallas, Los Angeles, Sacramento and San Francisco), with some in colour and others in black and white.

Video teleconferencing

Video teleconferencing uses a television-like image as well as sound for group-to-group meetings, usually involving only two groups at a time.[10] Video conference rooms are usually permanent and often elegant. The assumption behind video teleconferencing, which is usually unquestioned but has yet to be demonstrated, is that 'the closer a medium can come to face-to-face communication the better'. Johansen, Vallee and Spangler [11] point out that while video systems try to mimic face-to-face communication, it is almost impossible to eliminate the basic differences between an electronic meeting and meeting in person. Many people feel uncomfortable 'on camera': the image on a television monitor is different from face-to-face, and the studio atmosphere of some systems smacks discomfortingly of television and the movies. While they conclude that 'video conferencing appears to work for many meetings', they also note that a gnawing question remains: 'Is the full visual information always necessary for those meetings?'[12]

Video teleconferencing clearly is a technical reality, but it is complex and expensive. Complexity and cost are high because of the tremendous engineering effort required to make video images lifelike in size and quality, and because video requires 'wideband' communications to transmit the large amount of visual information involved on a continuous basis. Costs are difficult to estimate, but the *full* cost of video teleconferencing is currently about $400 per hour of usage,[13] at least five times as expensive as audio teleconferencing over comparable distances.[14] But high costs may not be the major impediment to the use of video.[15] Even at current rates, video conferencing compares favourably with travel costs, and the rates are expected to decline in the future as a result of technological improvements, such as video compression techniques, optical fibre signal transmission and efficient use of satellites.

Computer teleconferencing

Computer teleconferencing is print-based communication, usually involving 3 to 25 people who need not be present simultaneously, and who type their messages to each other on standard computer terminals linked by telephone to a computer network. Current applications range from message sending and simultaneous monitoring of crisis situations from multiple locations, to committee meetings and seminars among 'experts'. While most computer conferencing involves simple message routing, it can facilitate these broader applications through the use of other computer resources such as text editors, databases, journal systems, data

analysis packages, or models. Yet the 'strangest' feature of teleconferencing is that:

> With no images of the participants nor voices nor even a shared moment in time, a computer conference hardly seems like a 'meeting' at all.[16]

There are other drawbacks as well. Even though computer conferencing does not require skilled typing, and many conference participants get by as one-finger typists, some people never get over the discomfort of typing and others simply will not attend the conference because it requires them to type.

This problem might be solved by having someone else do the typing, in the same way a secretary types an executive's letters, but this can create its own problems. A major advantage of computer conferencing is its relatively greater accessibility, its facilitation of group communication irrespective of time and space, and its low cost. Johansen *et al* indicate that it is generally less expensive than using telephone and telex once the capital cost of the terminal itself is amortized.[17] They cite a 1975 forecast by Murray Turoff[18] that the computer portion of the cost of computer conferencing would be about $1 per hour by 1980. While they regard Turoff's forecast as optimistic, they feel that computer conferencing might be less expensive than audio teleconferencing by the mid 1980s.

Audio teleconferencing

Audio teleconferencing relies on the spoken word, and is not very different from the telephone 'conference call', with the exception that extra capacity for telecopying or telewriting is sometimes provided. The technology can be either permanent or portable, with the former consisting of specially designed (for acoustics) and equipped (table microphones, speaker cabinets, telecopying, telewriting) conference rooms, and the latter consisting of a simple portable speaker phone. The portability of audio teleconferencing and the increasing availability of public and private permanent facilities makes it the most accessible of the teleconferencing technologies. Currently, it is also the least expensive. The cost is especially low using the existing telephone network, although it increases as more people join the conference. Permanently installed systems which use dedicated lines are more expensive, although their cost can be justified if there is high use. The University of Wisconsin-Extension, which operates by audio teleconferencing at 200 sites throughout the state, estimates that its system costs about 25 cents per student per hour, not including the instructor's time.[19]

Audio conferencing seems to work especially well for regular committee meetings and for coordination meetings among members of specific projects who, while geographically separated, share a common task to be performed and have a high need to communicate with each other.[20] The major problems in audio teleconferencing are inadequate audio conditioning in conference rooms, low levels of reliability and voice quality of the audio technology, and difficulty in determining order of speaking when there are no visual cues to determine who *is* speaking, when someone is almost *finished* speaking, who is *waiting* to speak, and who should *speak next*. Technological and protocol solutions to these problems might be found, but an important question remains: can users eventually develop the same confidence in the technology for group conferencing by voice that they take for granted in one-to-one telephone calls?

[11] Johansen, Vallee and Spangler, *op cit*, Ref 9.
[12] *Ibid*, p 8.
[13] The full cost of the video teleconferencing system between Sydney and Melbourne, Australia is about $400 per hour of usage; a comparable rate is estimated for the Japanese NTT system between Tokyo and Osaka. The Picturephone® Meeting Service is available at partially subsidized rates of $390 per hour of usage between San Francisco and New York or Washington, DC. See *ibid*.
[14] R.R. Panko, P.W. Hough, and R. Pye, 'Telecommunications for office decentralization: apparent needs and investment requirements', paper prepared for IEEE International Conference on Communications, Stanford Research Institute, Menlo Park, CA, 1976.
[15] Interviews with Australian users indicated that the costs of video teleconferencing were considered reasonable. Business clients saw cost as no problem while government users saw cost as a bureaucratic problem – teleconferencing did not fit their budget categories. (See S. Ellis, V. McKay, and M. Robinson, *Follow-up Study of Users of the Melborne-Sidney Confravision Facility*, Swinburne Institute of Technology, Australia, 1976).
[16] Johansen, Vallee and Spangler, *op cit*, Ref 9, p 11.
[17] *Ibid*.
[18] M. Turoff, 'The future of computer conferencing', *The Futurist*, Vol 9, No 4, 1975, pp 182–195.
[19] L.A. Parker, and B. Riccomini (eds), *The Status of the Telephone in Education*, University of Wisconsin-Extension Press, Madison, WI, 1976.
[20] NASA's audio conferencing system has been used in this manner. The system grew out of the need for geographically dispersed contractors and NASA sites to work together on the Apollo Project, and is the most extensive network of permanent audio conferencing facilities currently in operation. The conference sites are equipped for voice transmission and high-quality telecopying to allow immediate exchange of diagrams and technical information.

Office automation

Office automation refers to a host of technologies related to the handling of information and communication among organizations. It includes the use of computer technology and data communication to provide electronic filing, text editing and document preparation, message service (electronic mail), analysis and simulation, remote query, graphics, and other data handling functions for work that would normally be done in an office. The technologies involved in any one of these functions are also varied. For example, text handling is performed by electronic typewriters, stand-alone or multiple-terminal shared-logic word processors, and communicating word processors that permit documents to be transferred to one word processor from another or to and from a general-purpose computer using data communications. Some word processors also interface with various methods of displaying and/or storing text information such as automatic typesetting and computer output microfilm. The important feature of these office automation technologies is that they provide the independent-location communications infrastructure and support services essential to large-scale implementation of work-at-home, satellite business-centre, and neighbourhood work-centre schemes aimed at reducing travel to work.

Unlike teleconferencing technologies, office automation technologies are inexpensive, widely available, and technologically well developed such that their use is highly reliable and relatively easy even though problems do arise.[21] Office automation is also the most rapidly changing of the technologies, with the changes moving primarily in the direction of providing more capabilities from a single work station (or computer terminal, word processor, intelligent terminal) and towards integrating the technologies to form comprehensive office automation systems. Generally, the reception of office automation has been high, except when the managements responsible for introducing them have made obvious errors in the name of efficiency.[22]

Telecommunications v transportation in energy economics

The importance of the foregoing telecommunications technologies is that they might effectively substitute for transportation, thereby increasing energy conservation. Transportation plays a significant role in the economies of most Western nations. Some measure of its significance is provided by estimates of the proportion of energy used by the transport sector in the USA, Canada and the UK. Tyler, Katsoulis and Cook[23] estimate that the transportation sector accounts for 25% of total energy use in the USA and Canada, and 15% in the UK. Moreover, the transportation sector accounts for 54% of total petroleum use in the USA, 41% in Canada, and 30% in the UK. And in Canada, 60% of the petroleum used is for the transport of people.

Further understanding of transportation's significance in the energy economy is provided by detailed examinations of the US situation. The most extensive of these have been conducted by Harkness,[24] who indicated that 53.4% of all petroleum in the USA is used for transportation. Three major kinds of travel make up the bulk of energy usage for transportation that might be affected by telecommunications substitution. These are business travel, the journey to work, and travel for shopping, entertainment and recreation:

- *Business travel* constitutes 8% of all US travel mileage (air, rail,

[21] Richard Canning ('The coming impact of new technology', *EDP Analyzer*, Vol 19, No 1, 1981, pp 1–13) provided several illustrations of the kinds of problems that are sometimes associated with these technologies in a recent *EDP Analyzer*. For example, with regard to commercial message services: 'Consider the case of a manager who, at 11:00 am, decides to see if there are any messages waiting for him in his mail box. First he must get to his terminal (which might be easy or might be difficult, if shared with others), dial the telephone number of the data network, log in, ask for the message service, log in to the message service, and then ask for any messages. If the group among which messages are being exchanged is small, there is a fair chance that there are no messages waiting. If this is the result that occurs a good fraction of the time, the manager will soon be reluctant to even look for messages' (p 11). Other problems with message systems included garbled messages, the data network telephone number being busy, the message system computer being down, or error messages not being understood.

Canning also reported that there are support deficiencies in the case of equipment failure, insufficient user training, documentation, follow-up training, and modification of the systems to better meet user needs. For some people frequently, and for all people at one time or another, loss of human contact is a problem with the office automation technologies.

[22] An illustration of such errors is the decision of many organizations to set up word processing units rather than to decentralize the capability within the organization. While this might increase the efficiency of the typing function and load up the new equipment as heavily as possible, it often results in job-function changes that are dysfunctional for the organization as a whole, as when managers must themselves perform functions (answering simple correspondence, answering phones, filing, searching files, making reservations, etc) previously performed by their secretaries who now have been replaced by word processing operators and 'administrative secretaries' assigned to handle the work of multiple managers. See Canning, *op cit*, Ref 21.

[23] M. Tyler, M. Katsoulis and A. Cook, 'Telecommunications and energy policy', *Telecommunications Policy*, Vol 1, December 1976, pp 21–32.

[24] R.C. Harkness, 'Telecommunications substitutes for travel: a preliminary assessment of their potential for reducing urban transportation costs by altering office location pattern', PhD dissertation, Department of Civil Engineering, University of Washington, Seattle, WA, 1973, p 456.

vehicle) and hence is thought to have considerable potential for energy savings from substitution.[25]

- *Commuting*, or the journey to work, generally is considered the most energy-consumptive of all types of travel. Harkness[26] estimates that the journey to work accounts for 27% of all US vehicle mileage, 25% of fuel consumption, and 11% of the nation's petroleum consumption.
- *Travel for shopping, entertainment and recreation* actually consumes the same amount of energy as the journey to work. But it is probably less substitutable and is highly sensitive to energy prices since it is discretionary.

Given the magnitude of petroleum use for intercity and intracity travel, transportation has naturally become a focus of national and international policy concern. If telecommunications can be shown to be more energy efficient than transportation, it might offer considerable potential for energy conservation.

Energy usage comparisons

Estimates of the amount of energy that can be saved when travel is replaced by telecommunications vary, but some order-of-magnitude results have been derived. Generally, they show telecommunications to have higher energy efficiency than transportation for substitutable trips, even when the limitations of such comparisons are considered.[27]

In theory, it seems that the energy required to transport someone from, say, Los Angeles to New York, for a business meeting would be much greater than that required to conduct the same meeting by means of electronic signals. However, as several researchers point out, both transport and telecommunications require an extensive and complex infrastructure of equipment, maintenance and administration which is poorly understood at present. Therefore it is generally felt that no purely theoretical calculation of the energy required to overcome friction, for example, or to propagate a signal along a coaxial cable, will provide an adequate estimate of energy usage. Instead, studies of the real performance of the systems concerned must be conducted.[28]

Energy usage comparisons of this kind have been performed by Katsoulis[29] for Bell Canada, and by Pye, Tyler and Cartwright[30] for the Long Range Studies Division of Post Office Telecommunications in the UK. The methods used are similar,[31] and the results point to essentially the same findings. Katsoulis[32] compared the energy usage for several modes of telecommunication and transportation among four Canadian cities (Quebec, Toronto, Montreal, and Ottawa) for meetings of varying duration among four people, two of whom would travel. He found considerable energy savings from the substitution of telecommunications for transportation, with energy efficiency increasing when the duration of the meetings is shorter and when the mode of transportation compared is automobile or airplane rather than rail.

Pye, Tyler and Cartwright[33] examined travel among four UK cities. They examined the comparative energy usage of three modes of telecommunications (studio-based audio system, viewphone and Confravision) and three modes of transportation (rail, air and car) for a three-hour meeting involving four people, two of whom would travel between London, Glasgow, Manchester and Birmingham. They found that with telecommunications substitution, energy conservation increased with the distance between cities, the number of people involved in the meetings,

[25] *Ibid*, pp 456 ff.
[26] *Ibid*, pp 456 ff.
[27] The major limitation of these studies is that they compare energy consumption for a single teleconference with that involved in travel to an equivalent face-to-face meeting; yet long-distance business trips frequently involve several meetings. This effect is far less pronounced for the much more numerous short-distance trips.
[28] M. Tyler, B. Cartwright and H.A. Collins, *Prospects for Teleconferencing*, Intelligence Bulletin 9, Long Range Studies Division, Post Office Telecommunications, London, 1977; M. Tyler, M. Katsoulis, and A. Cook, 'Telecommunications and energy policy', *Telecommunications Policy*, Vol 1, No 1, December 1976, pp 21–32; M. Tyler, M. Elton, and A. Cook, *The Contribution of Telecommunications to the Conservation of Energy Resources*, OT Special Publication 77–17, Office of Telecommunications, US Department of Commerce, Washington DC, 1977.
[29] M. Katsoulis, *Travel/Telecommunications Substitution – Its Potential for Energy Conservation in Canada*, Bell Canada, Montreal, 1976.
[30] R. Pye, M. Tyler, and B. Cartwright, 'Telecommunicate or travel', *New Scientist*, Vol 63, No 514, 1974, pp 641–644.
[31] Both the UK and Canadian studies used essentially the same conceptual basis. They distinguished between direct and indirect energy use, between average and marginal rates of energy use, and between the energy dissipated by the system under consideration, and the primary energy input used. The results summarized are for direct energy consumption and do not include energy embodied in goods or services consumed by the telecommunications systems. They do, however, account for all the primary energy input used in supplying the system's direct energy needs. The estimates of potential energy savings from substitution are also associated with an increment of traffic. They assume that the system capacity is adjusted proportionately to such changes in traffic and that overhead energy consumption by administrative or maintenance functions in the telecommunications and transportation organizations will not increase proportionately but are fixed overhead (Tyler, Katsoulis and Cook, *op cit*, Ref 23, p 23).
[32] *Op cit*, Ref 29.
[33] *Op cit*, Ref 30.

and the shorter duration of meetings. On the London–Glasgow link, which was the longest and is comparable to the Montreal–Toronto link studied by Katsoulis, they found that the substitution of telecommunications for transportation resulted in a 20% energy saving.

Potential magnitude of energy savings

While the foregoing comparisons suggest that telecommunications is more efficient than transportation in terms of energy usage, by themselves they do not provide an overall estimate of energy savings from substitution. Attempts to develop such an estimate have focused on (a) determining what share of the present or future volume of face-to-face communication could involve telecommunications rather than travel; (b) estimating what proportion of total travel such substitution could provide; and (c) calculating the resultant savings to total transportation energy and total national energy.

Although most writers have not been willing to make such overall estimates, because of the many problematic assumptions and the poor data sources available, Katsoulis,[34] and Tyler, Katsoulis and Cook[35] have made 'cautious' estimates. Basically, they have done so in the following manner:

- They used data from the Kollen and Garwood[36] survey of the attitudes of 9619 business travellers, who were presented with hypothetical telecommunications alternatives and asked their views as to whether their trips could be substituted by telecommunications. The survey indicated that 20% of the reported trips would not have been made had an acceptable telecommunications alternative been available.
- They also used data from the Kollen and Garwood study to determine what proportion of total business travel is travel to meetings. The study indicated that this proportion is about 75%. Thus, based upon these two proportions, the substitution potential of telecommunications for all business travel would be about 28% of the total. They indicated that these results converged with the results of demand-modelling studies, which indicated a substitution potential of just about 25% of total business travel.[37]
- They then calculated the energy savings realizable from substitution for intercity business travel, assuming that the substitution would occur on the scale envisaged above and that 'the policy environment (in terms of prices and budgeting for energy and travel) is such as to stimulate substitution and minimize generation effects'. Katsoulis's estimate of the savings that could be realized by telecommunications substitution for Canadian intercity business travel was 3% of the total energy consumption by the transport sector in Canada, 1.3% of total energy use.
- They then argued that to this must be added 'an allowance of direct trip substitution likely to occur within metropolitan areas'. Although no reliable estimates of intracity substitution impacts of telecommunications are available, they indicated that 'rough estimates made in the UK suggest that the energy savings may be on the same scale as the savings achievable in intercity travel.[38]
- Finally, based on the foregoing assumptions, data and estimates about energy savings, they concluded that 'it does not seem unreasonable to suppose that the overall total may be in the range of

[34] *Op cit*, Ref 29.
[35] *Op cit*, Ref 23.
[36] J H Kollen, and J. Garwood, *Travel/Telecommunications Tradeoff: The Potential for Substitution Among Business Travelers*, Bell Canada, Montreal, 1975.
[37] Tyler, Cartwright and Collins, *op cit*, Ref 29.
[38] Tyler, Katsoulis and Cook, *op cit*, p 30.

one to three percent of total energy consumption, or up to five percent of petroleum consumption, depending on national conditions'.[39]

By far, the most extensive estimate of energy savings from telecommunications–transportation substitution has been made by Harkness[40] in the form of a 'technology assessment'. The basic approach of the study was to generate a set of two intercity and four urban scenarios that embody various ways in which the interactions between telecommuncations and transportation might change, and then to assess, among other things, their energy consequences. The scenarios, which were designed to be technically and otherwise feasible in the light of current knowledge, were analysed on a 'what if' basis. Three types of scenarios were involved:

1. Use of two-way audio or audio-video teleconferencing systems as a substitute for face-to-face business meetings and thus business travel.
2. An increased rate of office decentralization from major central business districts to suburban locations, resulting in part from teleconferencing and other telecommunications improvements that make physical agglomerations less necessary.
3. Use of teleconferencing plus 'office automation' (as a replacement for paper-based information) technology to allow office workers to work at or near home.[40]

Based upon systems analysis of these three scenarios, Harkness[41] concluded:

Twenty percent reduction in business air travel could save about 80000 barrels of jet fuel daily in 1985 while the same reduction in business travel by auto would save 110000 barrels of gasoline daily. If 50 percent of all US office employees worked in neighbourhood office centers six out of every seven working days, the saving potential from reduced commuting is roughly 240000 barrels daily in 1985.

Figure 1, taken from the Harkness study, shows how these savings compare with other conservation measures identified by the Federal Energy Administration (FEA). It is interesting to note that the FEA estimates that every 100000 barrels per day in savings justifies a capital investment of about $8.6 billion. Thus, taken together, the above measures could justify a $37 billion investment in telecommunications substitution alone. Additional investment could be justified by savings in highway construction, mass transit construction and operation, airport expansion, and aeroplane development.

These estimates suggest that there is indeed potential for increasing energy conservation from the greater use of telecommunications in place of travel, although the potential savings are much less than many people had earlier thought they might be. Moreover, these estimates rest upon behaviour and cost assumptions which, while reasonable in the light of existing research, may or may not hold true in the future. Some indications of the behavioural factors involved in the substitution question can be seen by review of existing research on teleconferencing and teleworking.

Teleconferencing substitution for intercity travel

The urge to travel and see the world with one's own eyes will probably be enhanced, not lessened, by the availability of instant, personal picture communications; but the need for many ordinary trips for shopping, for

[39] *Ibid*, p 30.
[40] R.C. Harkness, *Technology Assessment of Telecommunications/Transportation Interactions*, Vol I and Vol II, Stanford Research Institute, Menlo Park, CA, 1977.
[41] *Ibid*, p 111.

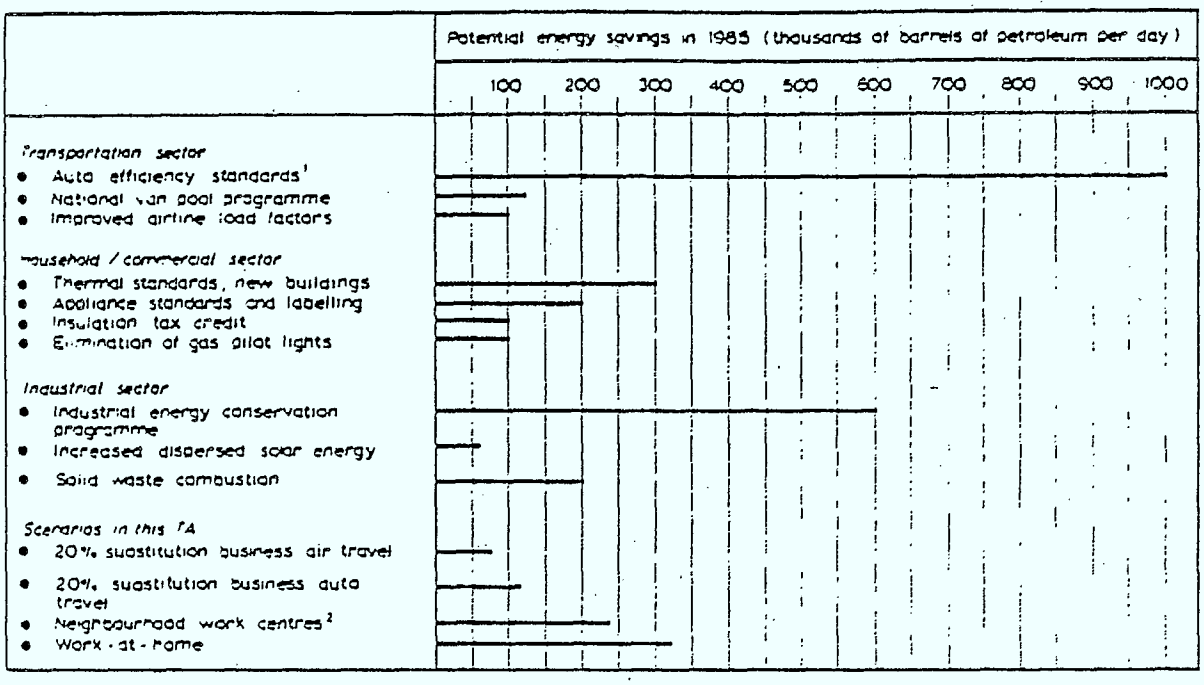


Figure 1. Harkness's estimates of energy savings of telecommunications substitution scenarios related to other energy conservation concepts.
[a]27.5 m/g in 1985 models; [b]these are not additive.
Source. R.C. Harkness, *Technology Assessment of Telecommunications/Transportation Interactions*, Vol 1, Stanford Research Institute, Menlo Park, CA, 1977, p 112.

conducting normal business, and for some social purposes should be greatly reduced. As a result, there will be less need for dense population centers. We can even hope to see an end to the continuing increase in city traffic jams. . .[42]

What actually happens when new technologies are introduced into society is partly a function of such visionary concepts. But effects are also influenced by the realities of what is technologically, economically, and behaviourally feasible and practical. While there appears to be no question as to whether telecommunications advances, such as teleconferencing, *can* be used as a substitute for some intercity travel, especially for some proportion of business travel, two key questions arise with regard to this prospect. Will the effectiveness and acceptability of teleconferencing be such that it will be accepted as a replacement for face-to-face meetings? If teleconferencing is accepted on a large scale will the net effect on transportation be to reduce, or to stimulate, demand for travel?

Substitutability of teleconferencing for face-to-face meetings

A number of theoretical studies have been conducted in an effort to predict the percentage and type of business trips that might be substituted by teleconferencing systems. These studies tend to be of two types: demand modelling studies and attitude surveys of business travellers. In addition, a number of operational studies of actual experiences with the use of teleconferencing have been conducted. The findings from these studies are reviewed next.

Demand modelling. Travel and telecommunications demand models have been constructed by the Long Range Studies Division (LRS) of British

[42] J.P. Molnar, 'Picturephone service – a new way of communicating', *Bell Laboratories Record*, Vol 47, No 5, May/June, 1969.

Telecom, and are similar in concept to the transportation modal-split models used to estimate the relative use of automobile and mass transit. The models simulate the future split of total 'interactive business communication activity' between competing travel and telecommunications media. The results of these modelling efforts indicate the *upper potential* for substitution because they consider only the effectiveness of various models of teleconferencing versus face-to-face meetings. On this basis, the LRS models indicate that 41% of all trips to business meetings (based on trip data from a stratified sample of about 1000 business meetings in the UK and 'assumed year 2000 conditions') could have been substituted by the narrowband teleconferencing devices without loss (or gain) in the effectiveness with which participants could communicate with each other. The addition of a video capability would accommodate another 9%.[43] These estimates apply only to travel to business meetings rather than to total business travel. However, as indicated earlier, data from studies in the UK and Canada indicate that about 75% of intercity business travel is to meetings. Therefore, the LRS results for substitution of business travel imply a saturation level of between 25 and 30% by the year 2000.

Attitude studies. Research on the attitudes of business travellers towards travel and the use of telecommunications constitutes the bulk of research on the substitution of teleconferencing for transportation and on the telecommunications–transportation question generally. The major studies, and their specific findings regarding various issues in the substitution questions, are summarized in Table 3. The quality of the studies reported there varies considerably due to problems of sample size, research bias, and quality of research procedures and instruments. Nevertheless, some general conclusions can be drawn from the better studies. Interested readers are urged to examine the specific findings in Table 3 as well as in two excellent reviews of the various studies by Gold[44] and Cordell and Stinson.[45] The general conclusions from the studies can be summarized as follows:

- Business travellers generally seem satisfied with the frequency of their travel.
- Most business travellers feel that they *need/desire* to keep their frequency of business travel at the same rate, or increase it.
- Most business travellers find some personal aspects of business trips to be as important as business aspects; but non-business aspects do not appear to be sufficiently important to enter into the decision making process that determines whether or not a trip is taken.
- The desire of business travellers to *decrease travel* is directly related to the rate at which an individual travels.
- Most business travel (75%) is to business meetings.
- Most business travellers attend meetings where the primary activity is one which theory and laboratory experiments have suggested is easily substituted for by teleconferencing media. In particular, they attend meetings which theoretically have high substitutability by audio or facsimile media.
- Most business travellers feel that they could not substitute teleconferencing for travel generally, or for their most recent trip
- Business travellers are prone to select audio and facsimile media rather than video and computer media as teleconferencing media to substitute for their travel.

[43] Harkness, *op cit*, Ref 40, p 50. The modelling effort did not account for possible 'generation' effects, did not take into account the importance of non-work-related considerations in choice of travel versus telecommunications medium, and was not calibrated using data on real travel and telecommunications choices (since suitable databases do not yet exist) (*ibid*, p 153).

[44] E.M. Gold, 'Attitudes to intercity travel substitution', *Telecommunications Policy*, Vol 4, No 2, June 1979, pp 88–104.

[45] A.J. Cordell, and J. Stinson, 'Travel and telecommunications: survey results to date and future possibilities', background paper prepared for the Science Council Committee on Computers and Communications, Science Council of Canada, Ottawa, 1979.

Table 3. Summary of major findings from research on attitudes towards business travel, and/or substitution of telecommunications for intercity travel.

Study source/ description	General attitude towards travel	Non-business activities of trip	Need/desire to decrease travel	Telecommunication substitution	Substitution by mode
Westrum [a] Doctoral dissertation: survey of about 400 plant managers and middle managers attending training programs at two US universities.	49% of the managers took 10 trips or more in a previous year. The managers were generally satisfied with the frequency of their travel: 87% felt they wanted to take the same number of, or more, business trips.	Business travellers find some personal aspects of business trips to be as important as business aspects. 78% felt that the personal aspects ('seeing things and places', 'enjoying new faces' were as 'important' as the business aspects or 'very important'.	92% felt they needed to take the same number or more trips than previously: 3% felt they needed to take fewer. 9% wanted to take fewer business trips. Desire to take fewer trips is directly related to the number of trips previously taken. 50% of those who took 0–4 trips in the previous year, 75% of those who took 5–9 trips, 87% of those who took 10–19 trips, and 82% of those who took 20+ trips desired to take fewer.		
Kollen & Garwood.[b] Bell Canada survey of 3619 business travellers between Montreal, Ottawa, Quebec and Toronto: considerable effort was made to give the survey the maximum feasible precision (by discussing with the respondent).	62% felt they would like to keep their frequency of business travel at the same rate or increase it.	56% participated in non-business activities (visiting relatives & friends, entertainment, etc.) during their business trips. Nonbusiness activities were not sufficiently important to enter into the decision-making process that determines whether or not a trip is taken.	37% of travellers wished to decrease the amount of travel while 15% wished to increase it. Desire to decrease travel is directly related to the rate at which an individual travels. 51% of those who travelled every other week desired to reduce travel.	The overwhelming majority (80%) of business travellers felt that their frequency of travel could not have substituted teleconferencing for their trip in particular. 20% felt they would not have taken the trip had an acceptable telecommunications alternative been available.	Business travellers were less prone to select video (58%) and computer (55%) media than audio (74%) and facsimile (75%) media as teleconferencing media to substitute for their travel. A large plurality of business travellers attended meetings where the primary activity was one for which teleconferencing media *theoretically* could be substituted. 80% of the travellers indicated that even if they had had access to teleconferencing, they still would have travelled.
Gold.[c] Jet Propulsion Laboratory surveys of about 178 JPL managers and non-managers, some of whom had used the NASA teleconferencing system available at JPL, used interview items from Bell Canada survey.			50% of JPL travellers felt they would have preferred not to have taken their last trip.	90% of JPL travellers claimed to know what teleconferencing was: over 80% were aware of the NASA system available at JPL. 5.6% of JPL travellers felt that method of teleconferencing, ferencing,	JPL travellers were about equally prone (39–43%) to select video, facsimile and audio teleconferencing media as a general substitute for travel. JPL travellers were more likely to select video teleconferencing as a substitute.
Israelski.[d] AT&T user-survey of Bell Systems Picturephone®					75% of PMS users felt it was a satisfactory substitute for travel.

Table 3 (continued). Summary of major findings from research on attitudes towards business travel, and/or substitution of telecommunications for intercity travel.

Study source/ description	General attitude towards travel	Non-business activities of trip	Need/desire to decrease travel	Telecommunication substitution	Substitution by mode
Meeting Service (PMS). Chumak [e] OECD market study on teleconferencing.				60% of business meetings could be conducted by some form of teleconferencing, but 40% required face-to face meetings.	40% of business meetings could be conducted through audio media with complete effectiveness. 20% of the meetings required video media.
Communications Studies Group [f] Used British civil servants as the test group.				54–72% of meetings could be carried out effectively using some form of telecommunications.	31—49% of meetings could be carried out through an audio system of communication. A video system could be considered appropriate for 23% of meetings.
Kahn [g] Review of 'informed speculation' by a number of researchers regarding the substitutability of telecommunications for transportation.					The 'informed speculation' of experts suggests that the ultimate substitution rate of telecommunications for transportation is 18–22%.

Source R C Harkness, *Technology Assessment of Telecommunications/Transportation Interactions*, Vol 1, Stanford Research Institute, Menlo Park CA, 1977, Table 4 p 41

[a]R M Westrum, 'Communication systems and social change', PhD thesis Department of Sociology University of Indiana, Lafayette, IN, 1972 [b]J H Kollen and J Garwood, *Travel/ Telecommunications Tradeoff: The Potential for Substitution Among Business Travelers*, Bell Canada, Montreal, 1975. [c]E.M. Gold, *Teleconferencing Implications for JPL*, JPL Report 900–873, Jet Propulsion Laboratory, Pasadena, CA, 1978; E.M. Gold, *Teleconferencing Implications for JPL*, JPL Report 900–896, Jet Propulsion Laboratory, Pasadena, CA, 1978. [d]E.W. Israelski, 'A user study of the Bell Systems video teleconferencing system: applications and attitudes', *Ergonomics*, Vol 22, No 6, 1979. [e]A. Chumak, 'The potential for telecommunications as a travel substitute', Role of the Automobile Study Working Paper No 10, Strategic Planning Group, Transport Canada January 1979 [f]Communications Studies Group *The Effectiveness of Person-to-Person Telecommunications Systems*, Long Range Research Report 003/ITF, Post Office Telecommunications, London, May 1975 [g]A.M Kahn, 'Travel v telecommunication: current understanding', *High Speed Ground Transportation*, Vol 10, No 3, 1976, pp 203–216.

- Managers are more prone to substitute teleconferencing for travel than are non-managers.

There is every reason to believe, based upon these findings, that business travellers will continue in their present travel patterns unless new political, economic or organizational factors stimulate them to modify their travel behaviour.[46] Moreover, although estimates of the potential rates of substitution of teleconferencing for intercity travel vary from a low of 6% to a high of 75%, the better studies seem to converge on the finding that the perceived substitutability of telecommunications for travel is about 20 to 30%. And the results vary depending upon the type of telecommunications medium offered as a substitute for travel.

Operational studies. Operational studies refer to those which examine the usage of operational teleconferencing systems. This type of study attempts to determine the extent to which an existing system has been used within an organization and the extent to which such use has reduced travel. There are relatively few teleconferencing systems operating currently, and there are relatively few studies which evaluate their actual use.

[46]One factor might be simply the wider availability of quality operational teleconferencing capabilities. For example, Harkness argues out that 'the actual adoption and fairly extensive use of teleconferencing within several large organizations [AT&T, IBM, Boeing, Aetna, and Proctor and Gamble] within the last year or two has laid to rest some of the uncertainty many of us had about its behavioural acceptability'. Harkness indicates that these systems are 'voluntary' and yet have had considerable use because they are convenient and save time. Still, better understanding of these systems is needed to determine what organizational factors are influencing current use (personal communication from Richard C. Harkness, 13 July 1981).

Gold[47] summarized and *critically evaluated* the results from the eleven functioning teleconferencing systems in North America, shown in Table 4. In two of the 11 systems, results of studies were not complete (and still are not).[48] Of the remaining nine systems, four showed actual reductions in travel, three showed reductions in travel budgets, and two showed no reduction in travel during the period of study. Based on these results, Gold concluded that:

> . . . no trend towards intercity travel reduction has been found. This is not to suggest that some organizations have not presented figures showing travel cost savings: many have done so. The evidence is that this does not indicate a reduction in travel, but is 'cost avoidance' – a measure of the cost of a trip not taken.

Gold's distinction between reductions in travel budgets (cost avoidance) and reductions in the frequency of travel is important because it articulates *two different* but highly relevant and objective indicators of substitution effects.

The operational studies to date have clearly failed to establish that telecommunications has significantly reduced travel, but it is important to remember that the studies are of technology developed in the late 1960s and early 1970s. Cordell and Stinson[49] argue that new systems, which are being produced, will yield a different outcome as regards the rate of usage:

> Acceptance will be a function of greater availability of systems hardware and therefore easier to access; rising energy costs and a desire by institutions of all types to control costs; better technology which is designed for interactive situations and a technology which takes account of 'people factors'.

Generation of travel demand by telecommunications

The answer to the second question in this section ('will telecommunications reduce or stimulate demand for travel?') seems to be 'it all depends'. Clearly, there is the possibility that any substitution effect will be wholly or partly offset by the stimulation of new travel demand. But two different approaches to answering the question seem to indicate that generated travel will generally be small. Tyler[50] used an aggregate

[47] *Op cit.* Ref 44.
[48] Personal communication with E.M. Gold.
[49] *Op cit.* Ref 45, p 6.
[50] M Tyler, 'Developments in telecommunications: the implications for transport', Long Range Studies Division, Post Office Telecommunications, Cambridge, UK, 1976, p 22.

Table 4. Summary of operational studies of teleconferencing—travel substitution

Organization	System type	Claim
Atlantic Richfield	Audio	No reduction
Bell Canada/TCTS	Video	Report pending; points to potential of reduced travel
US Department of Energy	Video	Cost avoidance
General Services Administration	Audio	Cost avoidance
Illinois Bell	Video	Travel expenses saved
JPL	Audio	Nearly 10% reduction over 3–4 years
NASA	Audio	Cost avoidance
Union Trust	Audio	Estimated savings of auto travel
United California Bank	Audio	Travel reduced, but less than expected
Pacific Coast Stock Exchange	Portable audio	No change
Public Service Commission Ottawa	Audio	Study underway

Summary of results from operational studies	
Travel reduction achieved	4
Cost avoidance achieved	3
No travel or cost reduction achieved	2
Study underway	2

Source: Elliot M. Gold, 'Attitudes to intercity travel substitution', *Telecommunications Policy*, Vol 3, No 2, June 1979, pp 88–104.

approach which deals with the overall volumes of communication and the total amount of time and resources committed to achieve them. He noted that improved availability or cost-effectiveness of telecommunications increases demand for communication in general, and also increases the proportion of total communication activity carried by telecommunications media. The former effect tends to increase transportation traffic whereas the latter tends to decrease it. The question is, which of the two effects will be larger? Using the concept of time-budgets, Tyler argues that if telecommunications takes over a significant share of a business person's present annual schedule of meetings, saving his or her travel time and thus presenting a bonus of free time, the generation effects generally will be small. This is because 'a business communicator is unlikely to "spend" all of the time he gains . . . in additional communication – let alone spend all of it on the mode of communication (travel) whose relative attractiveness has been reduced by telecommunications developments'.[51]

However, as noted by Harkness,[52] 'even if travel-generation effects are small in the aggregate, this may not be true for all classes of trips'. He therefore examines three 'generation hypotheses' about how the surplus of time and money (or both) created by substitution of some trips by telecommunications might be spent. His results, while interesting, are inconclusive about whether the net effect of substitution is to increase or decrease travel, but he seems to feel that travel-generation effects stimulated by telecommunications ultimately would be constrained by time, money, or other factors (eg organizational policy toward travel authorizations and budgets).

'Teleworking' substitution for intracity travel

The extent to which teleworking referred to as 'telecommuting' by Nilles, *et al*,[53] and others might substitute for commuting depends upon the type of work the commuter performs. Some work 'requires the physical presence of the employee at or near an immovable object or central location', (eg the creation of physical goods in factories, the transfer of physical goods or the performance of a service requiring face-to-face meetings.[54] The key feature of such work is that it is tied to some location and is therefore heavily transportation-dependent. Most researchers agree that it is difficult to foresee alternatives to transportation for workers engaged in such industries.

However, other kinds of work do not necessarily require the physical presence of the worker at some fixed location. This is generally regarded to be the case for work that is related to the creation, transfer, processing or storage of information, ie work in the 'information industries' such as education, insurance, banking, and finance. Thus it is generally felt that many information industry workers could 'telework' – they could perform their work, using communications and computer technologies, in their homes or at locations much closer to their homes than is often the case now.

There are no reliable estimates of what percentage of the office work force might ultimately adopt teleworking. Harkness[55] indicated that 'the only available estimate, which is without strong basis, suggests that roughly half the office work force is the upper limit'.[56] At this level, he estimated that in the US 'the neighborhood office center concept could save roughly 238000 barrels of gasoline daily in 1985 or the work at home

[51] *Ibid.*
[52] *Op cit*, Ref 40, p 58.
[53] J. M. Nilles, F.R. Carlson Jr, P. Gray, and G.J. Hanneman, *The Telecommunications-Transportation Tradeoff*, John Wiley & Sons, New York, 1976.
[54] *Ibid*, p 4.
[55] *Op cit*, Ref 40, p x.
[56] Jones estimated that 22% of all jobs in the San Francisco Bay area in 1965 were of types amenable to teleworking. Corresponding figures for the City of San Francisco were 31%, and for its central business district – 47% (D.W. Jones Jr, *Must We Travel: The Potential of Communication as a Substitute for Urban Travel*, Institute for Communication Research, Report RR-5, Stanford University, Stanford, CA, March 1973).

scenario could save 320000 barrels per day. This amounts to 1.02 and 1.40%, respectively, of total estimated 1985 petroleum consumption (these are not, of course, additive)'.

Substitutability of office automation for commuting

The major categories of work in the information industries that are thought to be most susceptible to teleworking are the managerial, professional and clerical levels involving, for example, various kinds of managers, information analysts, computer professionals, and information or word processing clerks. Indeed, several studies have concluded that a large number of managerial, clerical, and professional functions *could* be performed by using various modes of telecommunications, provided that certain additional criteria were met. For example, Reid[57] concluded that a large number of management functions could be performed effectively using telephone bandwidth communications, provided two criteria were met: (a) that the participants in the communication process know each other and are familiar with the contextual clues about each other's attitudes and emotions (this also implies that face-to-face meetings must be held and repeated occasionally); and (b) that some form of contextual or graphic display is provided in addition to the teleconferencing capability.

These and other studies have concluded that teleworking is cost-beneficial from individual, organizational, and urban-metropolitan perspectives. For example, Nilles *et al*[58] reported that:

> Instructional television as a telecommunication substitute for transportation offers the IITV user a substantial savings in time and travel. The director of the IITV system at USC, Dr Jack Munushian, estimated that in its first two years of operation, the USC IITV system saved 250000 commuter miles.

These potential cost and energy savings have led Nilles to predict that 'up to 10 million workers will be telecommuting by the mid 1990s'.[59] Whether such optimistic predictions are warranted is questionable.[60] Clearly, however, there are cost and energy savings to be achieved by increased use of teleworking particularly when viewed from an organizational and urban-metropolitan perspective. Moreover, to the extent that the time spent in commuting increases and the cost of energy also increases, one might expect that the savings to individuals could become sizable enough to encourage substitution of teleworking for travel to work among those who are able to seriously consider it.

The key question, however, is *whether individuals perceive teleworking as cost-beneficial to themselves* and, hence, whether they would be willing to substitute some form of teleworking for travel to work. A similar question arises with respect to the attitudes and behaviours of government and corporate managers: to what extent do managers perceive teleworking as cost-beneficial to the organization and, on that basis, would they be willing to permit or encourage their employees to use some form of teleworking or telecommunications-based neighbourhood centre in place of travelling to a central work location? A related question, independent of attitudes, is: to what extent do individuals and organizations actually substitute teleworking for travel?

As in the case of teleconferencing, two kinds of studies have been conducted to examine the substitution hypothesis with respect to teleworking: attitudinal studies and operational studies. The findings from each will be reviewed next.

[57] A. Reid, *Electronic Person-to-Person Communications*, University College, Communications Study Group, London.
[58] *Op cit* Ref 53, p 120.
[59] *Business Week*, 'The potential for telecommuting', 26 January 1981, pp 94, 98, 103.
[60] In a personal communication, Nilles pointed out that his prediction was based upon a number of assumptions not reported in the *Business Week* article which significantly qualify the prediction. Chief among these were that the cost of energy would continue to rise as it had in the mid 1970s, that the cost of telecommunications would continue to decline at the rate it had during the 1970s, and that organizational managers would increasingly 'internalize' the costs of commuting as a factor in worker productivity.

Attitude studies. Research on commuters' perceptions of the substitutability of telecommunications for travel, and on the perceived effectiveness of such substitution, fall into the category of attitude studies. A variety of researchers have asked, if teleworking capabilities were made available to commuters, what would be their attitude toward using them for work and communication in the place of travel? A potential problem with most of these studies is that they have assumed the most favourable situation in which to consider substitutability – that in which telecommunications substitutes do not involve a one-for-one functional task substitute or require considerable retraining or re-education.[61] Nevertheless, the studies provide some useful indications.

The most extensive attitude studies of teleworking have been conducted by Nilles and his colleagues at USC, but even these are limited by their sample size and choice of respondents. The USC group conducted five surveys as follows:

- An area-wide random probability sample of Los Angeles County adult residents via telephone interviews with 197 respondents.
- A sample of the USC population of enrolled Interactive Instructional Television (IITV) students using remote classrooms in their place of employment. These respondents were primarily professionals in engineering, aerospace and information sciences taking graduate-level education during released time.
- A sample of Stanford IITV students similar in characteristics to the USC group.
- A group of night USC commuter students similar in characteristics to the IITV groups.
- A sample of regular daytime undergraduate students enrolled at USC.

In summarizing the results of these studies, the respondents are divided into users and non-users of IITV, and the Los Angeles County sample.

Users of IITV. The IITV system at USC and Stanford is a television-based system which allows some modes of visual and oral communication – such as computer conferencing – which are not available on other types of communications systems, while making other models such as data look-up and text-editing more difficult. Nevertheless, the researchers felt that the attitudes of the users toward the IITV systems might not be materially different from the attitudes of clerical trainees toward a computer terminal system (a questionable assumption). The following conclusions were drawn from the survey of users of IITV:

- The major motivation for participation in IITV is a desire on the part of the participants to complete or expand their education or training.
- Users of the IITV system showed greater affinity for this mode of education over time, suggesting that familiarity with the system could favourably affect attitudes toward the system.
- Over 60% of the participants perceived IITV as being as effective as in-the-classroom education.
- Convenience and ease of use was a key factor in the willingness of participants to make the telecommuting/transportation tradeoff.
- About 60% of the participants indicated they would be willing to pay the cost of driving their car for the IITV service and 24% were willing

[61] As Nilles *et al* (*op cit*, Ref 53, p 111) point out, substitutions involving more complex work-technology linkages are likely to be threatening to individual employees and may create problems with pay scales, union contracts, etc. Consequently, worker resistance might be high.

to pay 50% more than the cost of operating their car for the IITV service.

Non-users of IITV. The non-user surveys were designed to assess the attitudes of people who were unfamiliar with computer and communications technologies toward telecommunications as a substitute for transportation. The objective was 'to get some estimate of the predisposition of the entry level information industry workers toward, or against, telecommuting'. Since the non-users included professionals in engineering, aerospace, and information sciences who were pursuing graduate degrees, as well as undergraduates, it is questionable whether this group really represents the predisposition of 'entry level information industry workers'. However, since the results for each group can be reported separately, they are nevertheless useful. The conclusions from the survey of non-users of IITV were as follows:

- The students who travelled the most were the least receptive to alternative forms of education delivery such as IITV.
- The primary reasons for their preferring to commute to campus were their preference for the campus environment and the interaction permitted by that environment, and, in some cases, the need to be on campus for part-time work.
- The part-time evening students, who had the highest average commuting distance of all groups sampled, were more receptive to IITV, with 36% indicating that they would use IITV at work and 46% indicating they would use IITV at home. Those who had a negative response to telecommuting again cited preference for the campus environment and interactions.

General population attitudes. The conclusions from the survey of Los Angeles-area adult population attitudes toward telecommunications substitutions for transportation to their jobs were as follows:

- Respondents were about evenly split regarding their willingness to work closer to home via telecommunications links, with about 51% indicating they were not willing.
- Respondents who were most receptive to telecommuting tended to commute the greatest amount and perceived their time as being more important than those who were not receptive to telecommuting.
- Most respondents preferred working closer to their homes but not in them.
- The majority of respondents would pay nothing additional per month for telecommuting, perceiving it as a fiscal responsibility of their employers.
- The overall attitudes of respondents toward commuting were positive or showed acceptance of commuting as a necessary evil.

The USC group also concluded from their surveys that the general public 'does not really fully comprehend the potential or operation of pending telecommunications developments'.

Taken together, the USC studies suggest that most commuters generally are not very willing to substitute various modes of telecommunications for travel to work or school. Those who appear willing to do so place several conditions on their willingness: that teleworking will be easy and convenient; that the cost to them be little or nothing; and that telecommunications-based working locations be closer to home, but not in the home. Since commuters generally view travel to

work as a necessary part of their job and are generally positive towards it, or view it s a necessary evil, it seems unlikely that commuters will readily choose, on their own, to substitute telecommunications for travel to work or school. A primary reason for their unwillingness is that commuters view work and school as having positive values in terms of social interaction and the general nature of the work/school environment.

Operational studies. The popular literature is full of descriptions of operational experiments with teleworking. For example, recent *Business Week* (26 January 1981) and *New York Times* (12 March 1981) articles cited a variety of business and industry experiments with the phenomenon:

- Control Data Corporation is engaged in a project called 'work station' involving 60 professional and managerial employees in voluntary work-at-home.
- Walgreen, McDonald's, and Mountain States Telephone and Telegraph are reportedly installing terminals in the homes of handicapped employees so that they can write computer programs without having to leave their homes.
- Continental Illinois National Bank and Trust Company of Chicago reportedly has been trying teleworking with word processor operators for two years in an effort to deal with the worsening shortage of secretaries and word processing personnel.
- Freight Data Systems of Inglewood, California, which provides computer time-sharing services and application packages for the freight industry, put computer terminals in the homes of computer programmers to reduce the need for additional office space.
- F. International Ltd, a British computer software company with 600 employees, 'has almost all of its employees working at home and about half use computer terminals'.

As noted by Margrethe Olson,[62] most of these experiments can be encompassed within four major remote work options, any of which might involve substantial telecommunications support. These options are: satellite work centres, neighbourhood work centres, flexible work arrangements and work at home. Satellite work centres involve the notion that a relatively self-contained organizational division, of some minimum size to achieve economies of scale in support services and equipment (eg 100–200 people), be physically relocated within convenient commuting distance of employees. Neighbourhood work centres involve employees from different organizations sharing space and equipment in a work centre close to their homes. Flexible work arrangements involve part-time work at home, as when 'employees are encouraged to take terminals home with them at night or on weekends to accomplish critical work at "non-peak" computer hours, or just for convenience so they do not have to make an extra trip to the office to perform necessary overtime work'.[63] Work at home involves employees working at home on a regular basis.

We contacted several organizations with such arrangements supported by telecommunications to discern whether there were systematic studies available which assessed their experience. Not one of the organizations contacted was able to provide us with a comprehensive report evaluating the telework experiments – either because such evaluations were not being conducted, or because the results were not yet in.[64] Conse-

[62] M.H. Olson, *Remote Office Work: Implications for Individuals and Organizations*', Center for Research on Information Systems, Graduate School of Business Administration, New York University, 1981.
[63] *Ibid*, pp 10–11.
[64] Control Data Corporation is conducting a more or less systematic study, but the results are not yet available. A preliminary report on the experiment is contained in R.A. Manning, 'Alternate work sites', text of a speech delivered at the National Transportation Conference, Washington, DC, January 1981.

quently, we tried to obtain information from telephone interviews with individuals in various organizations regarding the organization's experience. We also used the results of the exploratory research on remote work by Olson.[65] Our investigation, and that of Olson, revealed there are important differences in the teleworking experience depending upon the nature of the telework option, the nature of the job, and the nature of the individual's personal situation. Nevertheless, the following generalizations seem warranted.[66]

(1) The single largest group of workers currently affected by teleworking are computer programmers, data entry clerks, and word processing operators – people who have understanding of and familiarity with the technology.

(2) The number of workers involved in teleworking in any organization is a small proportion of the organization's total workforce, or even of that portion of the workforce most suited to telework.

(3) The major disadvantage of teleworking from the standpoint of workers is the loss of social and/or professional interaction with other workers. Clearly the extent of social or professional isolation varies with the kind of telework arrangement, with it being greatest under work *at home* options and least with work *near home* options.[67] Some individuals do not mind the social or professional isolation. A few individuals prefer to work alone. But most workers involved in teleworking, who have other feasible alternatives, do mind the loss of interaction and would prefer their old work arrangement or some new arrangement permitting closer interaction with fellow workers. As a result, some workers have returned to 'central' office work. A related disadvantage of telework is lack of visibility for promotion among peers and managers. This disadvantage is usually limited to individuals involved as members of an organization rather than 'contract' or 'piece' workers. Most current teleworkers are the former.

(4) The major advantages to individuals are flexibility in their working hours and location, reduced commuting time and cost, and ability to meet demands of personal situations. The latter can be especially important. For example, for the handicapped and those with family responsibilities, the advantage of being able to work at all is viewed as a reasonable tradeoff to social and/or professional isolation.

(5) The major advantages to organizations involved in teleworking are several:

- Increased work productivity; at least of the order of 10% and potentially much higher. Olson[68] and Manning [69] indicate that workers report productivity increases around 100%.
- Ability to hire people who will work for less.
- Ability to hire high quality or highly skilled people in a competitive market, when location and flexible work arrangements are important factors to potential employees.
- Ability to hire people who would not otherwise be able to work in the industry (eg the handicapped and single parents of young children) and who, by virtue of their inherent motivation or gratitude for being able to work, are likely to be highly productive workers.
- Reduced need for space to house office workers, and for heating and cooling of space.
- Shift of certain costs to the workers and others; eg the organization does not have to pay for employee downtime (eg due to equipment breakdowns), office space, or utilities. In contract and piece work,

[64] *Op cit*, Ref 62.

[65] It is important to point out that Olson's exploratory research was focused on 'remote work', whether it involved a substantial telecommunications component or not. Our interviews focused only on organizations involving 'telework'. The generalizations below attempt to factor out only the findings related to telework from both investigations. Readers interested in the broader issues of remote work should refer to Olson's full report.

[66] Both Richard Harkness and Margrethe Olson point out that there is a critical distinction between working *at home* versus *near home* in neighbourhood or satellite work centres, and argue that many of the disadvantages for managers and workers do not apply to working near home to the same extent as to working at home. For example, a neighbourhood or satellite work centre provides for greater social or professional interaction with work associates than does work at home. However, work near home presents its own special set of problems for workers and managers. For example, both Manning (*op cit*, Ref 64) and T. Citman (telephone conversation, 24 March 1981) report that even with decentralized office arrangements, central managers still have difficulty in knowing what to expect in terms of worker output, and can find the decentralized offices disconcerting because they reduce the manager's ability to visually monitor worker activity. This in turn can generate mutual distrust over issues of worker productivity. Also, while there is greater social and professional interaction for workers at the decentralized offices, it is not the same as being at the central office 'where the action is'.

Manning indicates that to deal with the foregoing issues, Control Data Corporation provides nearly all participants in its 'alternate work sites' programme with both a central office location (consisting of meeting rooms, pick-up and delivery stations for work assignments, mail boxes, and lockers) and an alternate work site. More than half of the work assignments are completed at these decentralized offices. In addition, CDC tries to promote 'open and complete communication', offers workers regular opportunities to attend meetings at the central office, provides special educational programmes for skill development, and uses 'feedback mechanisms' to discuss individual and group performance. Clearly, CDC would not do these things if they were not necessary.

[67] *Op cit*, Ref 62.

[68] *Op cit*, Ref 64.

the organizations also may be able to shift or reduce fringe benefit costs. However, this is likely to be only a temporary advantage, if it occurs at all. The price for contract and piece work will eventually be adjusted to include fringe benefits where not initially included by the unwary.

(6) The major disadvantages for organizations involved in teleworking relate to the management and supervision of the workers. To the extent that work can be parcelled out on a project or piece basis with a fixed cost attached, this problem is ameliorated; to the extent it cannot be so parcelled out, or employee productivity otherwise measured, supervision is made more difficult.[70]

Summary

The prospect that telecommunications might constitute a substitute for transportation, thereby resulting in energy conservation, remains just that – a prospect. Increases in energy conservation that might result from telecommunications substitution for transportation are difficult to predict. Reasonable estimates of such savings range from 1 to 3% of total energy consumption, or up to 5% of total petroleum consumption. But, the margin of error in these estimates is at least as large as the estimated energy savings, due to the problematic assumptions and data on which the estimates are based.

Moreover, the real potential of telecommunications as a substitute for travel also remains difficult to predict. While attitudinal research shows that potential substitutability of 20 to 30% exists, the operational studies to date have failed to clearly demonstrate that travel reduction or travel avoidance has occurred with existing telecommunications systems. One reason for the poor performance relates to the relatively slower rate of diffusion of telecommunications technologies than had been anticipated earlier. For example, Johansen, Hansell and Green[71] recently wrote that teleconferencing:

> . . . has not yet been implemented on anything like the scale anticipated in the early 1970s. Certainly teleconferencing has been successfully used by some organizations . . . Mostly, though, teleconferencing consists of vague promises, often the same promises that were made 10 years ago. It sometimes seems as though nothing has been learned over the past decade, that many of today's promoters of teleconferencing are merely restating old – and largely unfulfilled – promises.

And teleworking, the natural child of the teleconferencing idea, seems to have fared no better during the past decade than its parent.

The research clearly suggests that while telecommunications technology might yet substitute for travel, it will not happen quickly, and probably will not happen without changes in attitudes, behaviour, technology, and economics. These factors, which influence individual and organizational users' decisions about whether to substitute telecommunications for travel, are examined in Part II of this article.[72] Also examined are major views of the government's role in relation to increased use of telecommunications for achieving energy conservation, and specific mechanisms of government policy for affecting telecommunications substitution.

[70] Olson summarizes the problem nicely as follows: 'From management's point of view, the primary problem with telework is how to supervise people who are out of sight. Many managers I have spoken to feel it is not feasible unless a job has measurable outputs, even though comparable measures are often not necessary for in-house personnel performing the same jobs. Thus, acceptance of the idea by management will probably not come before either output measures are developed (possibly indexed to compensation) or fundamental changes in management attitudes take place'. (Personal communication from Margrethe Olson, 5 October 1981).

[71] R. Johansen, K. Hansell, and D. Green, *Teleconferencing Growth: Looking Beyond the Rhetoric of Readiness*. Institute for the Future, Menlo Park, CA, 1981, p 1. See also Robert Johansen, Kathleen J. Hansell and David Green, 'Growth in teleconferencing: looking beyond the rhetoric of readiness', *Telecommunications Policy*, Vol 5, No 4, December 1981, pp 289–295.

[72] To be published in *Telecommunications Policy*, June 1982.

A REALISTIC APPROACH TO IMPLEMENTING OFFICE AUTOMATION

The following article was adapted from a speech given by Gerald Tellefsen, Senior Vice President of Booz, Allen & Hamilton, Inc., at the Seventh Annual International Conference of Wang Users in December 1979.

Designing and implementing an automated office involves the development of training, orientation, and selling programs to prepare management personnel for the new tasks and responsibilities they will face in the future. The automated office that I refer to comprises combinations of many new technologies, as well as technically advanced subsystems such as improved processing, micrographics, and photocomposition.

In an effort to understand the education process required in establishing the automated office, I will look at some of the existing attitudes of today's office worker, propose some basic guidelines for designing an office system, and discuss how to gear our education programs to an implementation schedule.

Existing Attitudes towards Office Automation

As a result of my work experiences and particularly the results of a recent managerial productivity study, it appears that the attitudes of people in an office can be organized into three categories. Often you'll find that people in the same office fall into particular camps. The first camp, which I call Camp Reluctant, includes those people who are not too anxious to get involved with office automation or to participate in it. The second camp, called Camp Gung-Ho, includes those people that are high on office automation and new technology. And the third camp, called Camp Indifferent, are those people that are neither aggressively for or against it.

Let's examine why people tend to fall into these three categories. People that fall into the category called Camp Reluctant have the following characteristics: They're wary of change. They do not initiate changes of their own. They've been doing things the same way for a long period of time, and, quite naturally, find it comfortable that way. Possibly, at one time, they were persuaded to purchase an expensive data processing system that employees didn't like, and now they are skeptical. Once they get comfortable doing something the same way and doing it well, they are afraid that a computer will drastically change the way things are done, possibly not doing them as well.

The people categorized as being in Camp Gung-Ho have the opposite characteristics. They are very positive about office automation, often without having much knowledge or experience. They may be aggressive and harebrained, which means, for example, that they want the whole scope of the office changed immediately and a computer installed on every desk. However, even though their ideas may be viewed as radical, you will often find that these people are creative. They are, in fact, looking for ways to increase productivity in the office. When you boil down office automation, or any area of high technology, it gets down to increasing the profitability of the organization by increasing the productivity of the people, which takes these creative capabilities.

People in these camps have these attitudes for a reason, and very frequently, it is a lack of communication and education. For example, the people who are reluctant might feel as if the people who are positive don't understand their situation. However,

The attitudes of people in an office can be organized into three categories.

the people who are positive might expect everyone in the office to go along with their suggestions without question because they believe that an automated system will be beneficial to all. The pessimist who has been burned in the past is not reassured by the optimist's statement that "this time it's going to be different." Obviously, the people in Camp Gung-Ho are not addressing the real concerns or problems of the people in Camp Reluctant and, of course, the reverse is true as well.

These attitudes reflect a wide gap in communication between the two camps. In addition, the people in Camp Reluctant might not understand how the system works and, therefore, they may not foresee an increase in productivity. They might not care if overhead costs are reduced because they have managed to stay within their budgets in previous years. They might not be concerned with regulatory and competitive pressures because their department has little to do with marketing or with meeting any kind of regulatory requirements. These attitudes are again the result of a lack of education in both camps.

The pessimist who has been burned in the past is not reassured by the optimist's statement that "this time it's going to be different." Obviously, the people in Camp Gung-Ho are not addressing the real concerns or problems of the people in Camp Reluctant and, of course, the reverse is true as well.

Learning How To Hurdle

How do we sort out and change these kinds of attitudes in the office? The common denominator between opposing views is that everyone learned to do things in a certain way at one time, and they can be educated again. The problem is trying to discover exactly which educational procedure is appropriate for your company. An important step is to find out the personality of your organization. Almost every business has a personality, and typically it's reflected by the chief operating officer or the chief executive officer. That attitude or personality is usually influenced by how productive a company has been during the course of a year and how much it has grown. Once you look at the personality in your particular office, you may find that there are certain stumbling blocks that will prevent you from getting office systems installed. I have categorized these stumbling blocks into seven hurdles that you may have to overcome.

The first one is the ignorance hurdle. How do you get over the hurdle of convincing people who don't understand what you're trying to say? One of the things that might be done is to involve top and middle management by making presentations of your proposal and your view of the current situation. Additional solutions might be to route appropriate articles through the office and to conduct periodic seminars with outside specialists, inviting office personnel to attend. Many people are bamboozled by the state of electronics today. They don't understand how today's office systems work, who has used them before, and what occurs when an automated system is installed in a manual office.

The second hurdle that might be evident in your organization is the fear hurdle. When you see that people are afraid, talk with the person in charge and find out why there is fear. When you present your proposal for a new office system, it is essential that you are able to identify the potential negatives because every installation has a particular kind of risk. No one will believe you if you try to sell something and claim it's going to be 100% right. You should then identify a contingency plan, a fallback plan. If you can show someone alternatives to problems in the system, then they may be less afraid. Finally, your approach to the installation of the system should be based on a philosophy of evolution rather than revolution. This will reassure the manager that overnight something will not happen that's going to make it difficult to control the situation in the future.

The third hurdle is the "I'm from Missouri" syndrome. These are the people who do not believe something until they see it. In response to this, you can distribute articles on similar systems that are in place and that are successful. You might even escort them to a live demonstration of a working system. If you can actually show somebody something that works, you may turn that person into an advocate of what you want to do.

When you present your proposal for a new office system, it is essential that you are able to identify the potential negatives, because every installation has a particular kind of risk.

The fourth hurdle is the pessimism hurdle. It's difficult to deal with people who are not positive about anything. You can try to keep them informed and communicate whatever achievements you're making in other places within your organization. You might also treat them like the "I'm from Missouri" people by showing them a live demonstration of a system similar to the one you are proposing.

The fifth hurdle that may exist within your organization is the over-enthusiasm hurdle, which is the reverse situation. It's typified by the user who is hot to get something done on a high-technology basis, either within the department or across the whole organization. In handling this, it is important to stress the need to walk before running, since long-term success requires careful planning. However, an enthusiastic person is the ideal type to use as a volunteer for a pilot study. If your initial experiments work out well, he or she will be advertising it to everyone. Also, the spirit of these kinds of people can be channeled to the pessimistic people. For example, if you're having a meeting to present something to six or seven managers, try to arrange the seating so that the positive or enthusiastic people are next to the pessimistic ones.

The sixth hurdle is the accountant syndrome. Without really handling this hurdle through education, your chances of getting a system installed are slim. You must be knowledgeable in the economic aspects of the current and future situation. It may be necessary to present the front-end and operating expenses in detail, as well as the hard and soft dollar savings. If you can give the accountant these kinds of numbers,

your proposal has a much better chance of survival.

The final hurdle is the human-factor syndrome. If you're going to install a system, you must be aware of the associated personnel requirements. You must determine exactly what kinds of people, or expertise, you will need to design and develop that system. You can then relate the resulting jobs to the existing staff to find out if the system will work with current personnel. In assessing the human factors involved, it is important to be aware of what the experts have to say about working conditions.

It is important to stress the need to walk before running, since long-term success requires careful planning.

Everything from the design and color of the office to the career path options for operators should be considered. Another important step is to discuss human engineering requirements with experts because many people find it hard to believe that they can change the way they work. You must have information on methods of changing people's work patterns and be able to show how these methods have worked in other places.

Designing an Automated Office System With Your Eyes Open

Before planning an educational program, a decision should be reached on what type of system best suits the needs of your office, and approval must be given by management for installation. I will describe some basic steps to use as guidelines for designing a system that will accomplish the goals you have set for your automated office.

From the beginning of your search, it is important to go in with your eyes open. You should understand the real differences between automated and manual systems. Manual systems are typically more intelligent, easier to learn and easier to make adjustments to. They are a flexible investment commitment. However, with automated systems, you have an inflexible investment commitment. Training must be proceduralized, and technical expertise is necessary to increase the learning curve as people learn to use word processing. You must have a detailed definition of how the office procedures will work. Also, you need to determine if the equipment you are using will obsolete itself. These are major differences that should be considered in finding the best approach to designing your new system.

Another basic step is to become knowledgeable about the system you are trying to improve. This includes defining the purpose of that system, its functions, the components, the staffing, the operating expense, the problems, and the efficiencies.

The next step is to establish the objectives of the new system, such as saving money, improving service. Research automation concepts, publications, authors, vendors and consultants. Basic selection criteria must then be defined in order to support your proposal. For example, this criteria might be the cost of the system, proof of its performance, processing and speed requirements or vendor support. The major criteria you use to choose an office system must directly relate to the needs of your particular firm.

With the research you have done, you are ready to design your automated system, the functional flows, the personnel needs, the ongoing costs, and a manual fall-back system or outside service program. As a final step in this process, you should compare the offerings of potential vendors and select the most qualified. System requirements and detailed selection criteria should be given to appropriate vendors. By comparing and ranking vendor responses, you should then be able to select a vendor.

When the design of the new system is complete, a schedule for implementing the office automation should be developed. You may decide on a short-range or long-range automation schedule, depending on the type of system to be installed. There may be direct and indirect uses of the system you would like to develop in the future which would require a phased schedule of implementation. Your plan will also need to reflect management psychology, style, and attitudes of the office. Therefore, the education program for office personnel must be geared specifically to what the automation schedule will be. This should help get a system accepted, installed, and running on a successful operating basis.

Educating For Success

Systems can be organized into two types — shared and dedicated — and they require different kinds of education and different kinds of work steps. There are seven major steps to an education program that will accompany the design, installation, and operation of a shared office system (systems that are used by everyone). Each step is aimed at a certain kind of person, with a certain rank, and is done at a certain time. Also, there is a particular media that best fits each situation.

Your plan will also need to reflect management psychology, style, and attitudes of the office. Therefore, the education program for office personnel must be geared specifically to what the automation schedule will be.

The first step is the presentation of results from research you have done on a certain system. After the study is done and you have decided this is the appropriate system for your office, the study results are to be prepared in the form of a written report. It is a summary of your research that should be presented to all the managers in that particular location who might be affected by the system. It should be done once, a few months before implementation.

The purpose of the second step is to introduce system procedures. This can be a formal presentation, a procedures manual, a usage card, or all three, depending on what you want to get people to do. The participants will be managers and usually secretaries, and this should be done once, a month before implementation.

The third step is to make an announcement a week before the switch to the automated system. The method should be a memorandum which is distributed to all participants. This kind of announcement is signed by someone in a high position in your organization.

Two months after the system is up and running, a status report should be written as a fourth step, and it should be distributed to the managers. If you've finally convinced people through the education program to participate in the implementation of a system, you should not forget about

them. You should follow up by indicating in your status report what happened in that first two-month period of time.

The fifth step is also a presentation to the managers, to be given once, three months after new procedures are in effect. The subject is user-status results, and the purpose is to inform each manager of how his/her department used the system, how they liked it, and how often they used it. It should include the comments and concerns of the individual users. A department usage report should also be circulated as a sixth step, which should include, among other things, the frequency of use and the cost of use.

The last step is orientation, a very important thing. When we change procedures and install a new system, we have to change our orientation procedures for new hires or for transfers to tell them about the new system and how it will be used in their jobs. It is only necessary once and should be done during their first week of employment.

The other type of system, a dedicated system, requires a different selling program and a different education program. A dedicated system is requested by one person in a department, typically the department head. This person wants some kind of office system installed, but enlists your help in making the decision. The first major task in this situation is to present a prefeasibility study, which reviews the reasons for considering an automated system and states the expected benefits of implementing one in the department. When the study is completed, a presentation should be made to the department manager who enlisted your help and a cabinet consisting of two or three of his or her most respected advisors.

The next task is to conduct the feasibility study, and then follow up the prefeasibility study with another presentation and a written report. The participants are the manager and the cabinet. It should be held immediately after the research on your proposed system is completed. It is very important that, after the study is completed, you don't take a three or four week hiatus before you report the results back to the people in the department in which you're working.

When the study results are approved, the next step is the actual design of the system. The media should be a team with one or two participants from the department staff as well as the manager and cabinet. The idea is to involve the users as much as you can in the design of this system. After the system design is finished, the operating procedures should be written and distributed to all users. This is done once, a week before the pilot begins, so it's fresh in their minds prior to the beginning of the pilot.

At this point, the pilot study itself is conducted. It is very personal because you are right there with them. The participants should be users from that particular department. At the end of the pilot study, the results should be given as part of a presentation. The participants should be a team that includes the systems person and the one or two people who were helping with the pilot and with the study itself.

Systems can be organized into two types — shared and dedicated — and they require different kinds of education and different kinds of work steps.

Time should be allotted to discuss the results, the benefits and whether it went as well as predicted.

The final task is setting up an orientation program. In this particular case, the orientation is for people who are learning the system from the beginning. This should be done through the use of a manual. The participants would also be new hires and transfers, and again, the orientation should be done during first week of employment.

In summary, an education program can help us overcome the many hurdles we face even before we gain approval for the installation of a system. After approval is given, however, the education program doesn't stop. Sometimes an education program, in fact, may take the form of a little marketing program. If you have a happy user, you have someone who will advertise what you have done.

An education program can help overcome the many hurdles we face even before we gain approval for the installation of a system. After approval is given, however, the education program doesn't stop.

When that happens, the productivity gains that you're looking for should, in fact, occur.

To review, you should begin by identifying your corporate personality. Define the type of education your organization will need, and what kind of hurdles you will have to overcome. Management attitudes should be given careful consideration. Then develop a multifaceted, multimedia education program that includes face-to-face presentations, written reports, memorandums and instruction manuals. Last of all, assign the necessary personnel to the education program. You will need people to take the responsibility for their specific tasks during the entire phase, from system design to implementation. □

OFFICE OF THE 80s
Productivity Impact

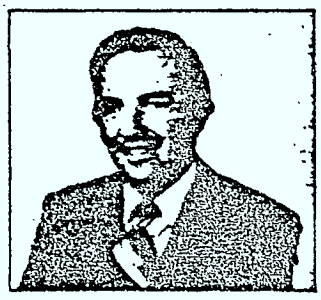
by John J. Connell

The key consideration in planning for the Office of the 80s is the bottom line. Much has been written about exciting new technologies that have been developed for the office, such as computing capabilities on a chip the size of one's fingernail, mail moving electronically, instantly accessible microfilm records, conferences by video and similar advances. A great deal of thought has been given to the growing trend toward interconnection of office machines through telecommunications and the impact these developments have on office operations. Substantial interest has been shown in the benefits associated with accelerating information flows, substituting telecommunications for travel, introducing the concept of an electronic in-box and similar developments. These technological breakthroughs are exciting, the benefits are real and the opportunities for improvement in the future office are very attractive.

In today's office the cost of operations is rising faster than any other segment of business. The labor-intensity of the office makes it especially susceptible to escalations in wages and fringe benefits; the workload of the office continues to grow; and the track records of periodic cost reduction programs are not very impressive. Unless these trends can be reversed, the office will have an increasingly negative impact on profitability, threatening the health, and perhaps even the continued existence of many enterprises.

The time has come to call on senior management to confront the office operating cost problem by introducing programs to improve office worker productivity, as a basic business strategy. The well-meaning but hit-or-miss approaches now being pursued by office personnel to achieve these goals, with varying levels of management support, are not sufficient. What is needed is an intensive effort, at all levels, orchestrated by an aware and concerned senior management.

This special supplement addresses the problems and the potential of the Office of the 80s. It describes why office costs are rising; proposes that increasing office worker productivity at all levels should be a key managerial objective; describes approaches, tools and techniques for achieving that objective; and discusses the opportunities and the pitfalls in managing the move into the Office of the Future.



John J. Connell is the founder and executive director of the Office Technology Research Group, Box 65, Pasadena, CA 91102. The Group is an international association of executives from major corporations who are concerned with the organizational, behavioral and managerial implications of introducing advanced technology into the office. Previously, Connell was Vice President of Administrative Services for Atlantic Richfield Company.

Office Costs

How much do offices cost—last year versus this year versus next? In reality, most executives do not know. Few accounting systems are designed to accumulate and report total office costs in a meaningful way. Defining just what an office is, and what expenses to classify as office expenses, as opposed to line expenses, are difficult tasks in themselves. Conversely, orienting the accounting system to measure office operations accurately can skew the reporting of performance for the enterprise as a whole.

The Business Problem: Office Costs Are Rising Precipitously

As a result, there is little general information available on the subject of office economics. However, when special studies are undertaken to pinpoint office performance, the results are startling. The studies reveal that office costs are rising 12% to 15% per year, and there is nothing on the horizon, short of concentrated action by management, to reverse this trend—in fact, just the opposite. The same studies indicate that office costs will double over the next six years. Most businesses cannot sustain such cost increases without a negative impact on the bottom line. (See box next page).

Thus, a major business problem has arisen, which must be addressed by top management. Otherwise, the gains in the marketplace and the efficiencies of the factory will be wiped out by what is happening in the office. Managers responsible for office operations have been attempting to solve this cost increase problem for many years. Substantial inroads have been made by computers in certain sectors of office operations. Word processing, micrographics, and other office technologies have had similar impacts in other areas.

In spite of these efforts, as successful as they have been, office costs continue to rise.

Payroll and Workload

Several factors contribute to office cost increases, including the impact of rising energy prices on office space costs and the general effect of inflation on office expenses. However, two factors predominate: labor costs and total workload. With upwards of 75% of office costs labor-related, every wage increase and additional fringe benefit has a disproportionately adverse effect on expense levels. The total workload that the office is called upon to handle is increasing and so are the total numbers of office workers.

The key product of the office is information, and most of the functions performed by office personnel are concerned with the processing and the communicating of information. If demands for information grow, then office personnel must meet those demands. If the demands cannot be met by existing mechanized systems, then the information must be ferreted out manually by office personnel—a time-consuming, inefficient and particularly expensive process. If the demands are voluminous enough, then additional personnel must be added to the office work force to handle the expanded workload.

In fact, that is exactly what is happening. A mushrooming demand for information is being imposed on the office, from within and without. The external demand comes from the growing numbers of regulatory and other governmental agencies, at the federal, state and local level, which demand information from business that seldom matches the output of existing mechanized systems. Either new systems have to be devised or the demand must be met through manual effort.

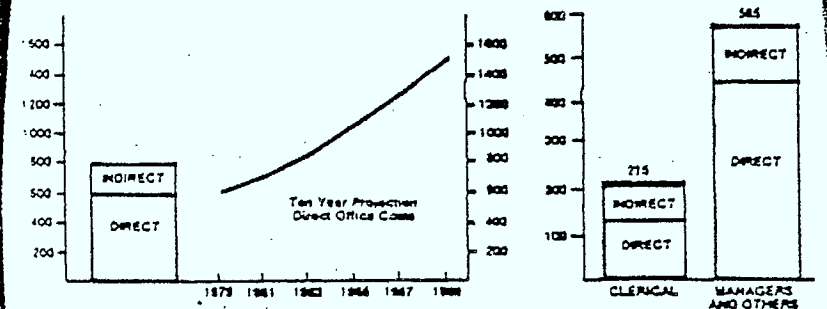
Internal information demands, on the other hand, arise from the success stories in information systems—new systems which provide management with operating information oftentimes not available in the past, presented in a form and time-frame geared specifically to executive needs. The success story is short-lived, however, because information demands which are successfully met invariably beget additional demands, as the power of machine-based systems becomes evident. Sometimes, the systems can meet these new demands. In most cases, just as with the regulatory agency requests, the burden falls on office workers to assemble the requested information manually.

Productivity Improvement

The problem, then, is a constantly increasing workload being handled by growing numbers of increasingly expensive office workers. The only reasonable solution is to introduce tools and techniques to improve the productivity of office workers so that these workloads can be absorbed without additions in personnel, and salary increases can be offset. Once those two objectives are accomplished, one can begin to think about approaches which actually reduce office costs.

1979 Office Costs U.S. Business

($ Billions)



Of the $800 billion U.S. businesses are expected to spend in 1979 on office operations, $600 billion represent the direct costs of compensation and fringe benefits. The remaining $200 billion of indirect costs cover internal support, space and purchased resources. If major steps are not taken to introduce new technologies into the office in a comprehensive way, direct costs of office operations could rise to $1.5 trillion by 1990.
(Source: Booz, Allen and Hamilton, Inc.)

Clerical costs amount to only 23% of direct office costs and 27% of total office costs. The remainder represents the costs of managers, professionals and other knowledge workers.
(Source: Booz, Allen and Hamilton, Inc.)

The Business Solution: Improve Office Worker Productivity

Efforts to improve office worker productivity, then, must first be geared to shoot at moving targets—workload growth, work force increases and escalation in labor costs. Second, they must address the fact that improving clerical efficiency has been the aim of systems designers for years, with considerable success, and although improvements still can be made in some areas, the potential margins of improvement are not very great. However, clerical labor costs represent less than one-third of office labor costs. (See box). Two-thirds represent the cost of managers, professionals and others who represent fertile ground for productivity improvement efforts.

The first step, if the effort is to succeed, is for senior management to establish improvement in office productivity as a corporate goal and to solicit participation of all office personnel in achieving that goal. The Westinghouse approach, which is described in the accompanying box, is an excellent example of how one of the country's more progressive corporations has initiated a corporate-wide productivity improvement program.

Next, one must recognize that little is known about how to measure the productivity of managers and other knowledge workers. As a result, proposed approaches which claim to improve managerial productivity often cannot be quantified accurately. Several efforts are under way to find answers to this problem, the most comprehensive of which is the American Productivity Center's IMPRINT project (IMprovement of PRoductivity with INformation Technology), described in the box on following pages.

The introduction of productivity improvement projects should take advantage of techniques that have been developed to facilitate office worker participation in the productivity improvement effort. One such technique is called "quality circles". The circle, which consists of all workers in an office or section, meets weekly to identify problems and to set priorities for solving them. Another approach, called the

Nominal Group Technique, is being used by the National Micrographics Association in connection with both its research into office productivity, as a public service office operations. (See box on following pages).

Investment in Technology

Establishing a corporate goal of productivity improvement; getting all office workers involved; recognizing the difficulty of measuring improvements in managerial productivity; and using the tools and techniques available are key steps in getting started. In addition, one should look to the nation's history of productivity improvements on the farm and in the factory. In so doing, one becomes quickly aware that improvements in productivity over the years have been directly related to capital investments in technology. (See box next page).

Studies indicate that capital investment in the farm worker approaches $70,000 and the factory worker approximately $35,000. The office worker, on the other hand, is supported by a capital investment of about $2,000. Little wonder, then, that the three do not contribute equally to the nation's productivity. The disparity in capital investment per office worker, as opposed to investments to support farm and factory workers, is reflected quite directly in the relative productivity levels of the three groups.

The conclusion that one has to draw, therefore, is that any serious effort to improve office productivity must call for well-managed investments in new office technologies. Fortunately, there has been an explosion in new office technologies, in the numbers of machines available, in their capabilities and in their potential uses. Further, in direct contrast to the continuing increase in people costs, the cost of technology is decreasing. Breakthroughs in the laboratory, occurring almost daily, provide frequent improvements in the price/performance ratio of office machines, and this trend is expected to continue. (See box next page).

A Comprehensive Plan

The tools are here today, or will be shortly, and the economics are increasingly attractive. A comprehensive plan is needed to introduce these tools into every phase of office operations, as a basic business strategy. It is at this point that programs to improve office productivity often go awry. As soon as technology is mentioned, there is a tendency to delegate responsibility for such pro-

Westinghouse Approach

Westinghouse Electric Corporation has initiated a major corporate-wide productivity program, strongly supported by senior management, and designed to enlist the participation and support of Westinghouse personnel at all levels. A Corporate Productivity Committee has been established, made up of key executives in the operating companies and chaired by Thomas J. Murrin, President of Westinghouse Public Systems Company. Some of the activities undertaken include:

Programs to make all employees aware of the importance of productivity improvement to Westinghouse. A Management Council meeting, which included the top 200 executives in the company; individual and business unit meetings; roundtable discussions; attendance at external seminars; internally produced videotapes and a number of other efforts have been undertaken, aimed at increasing employee awareness of the importance of productivity improvement.

Programs to establish productivity improvement as a corporate goal. Productivity improvement plans have been made a formal part of the strategic and business planning process; seed money has been provided to test productivity improvement ideas; and wide exposure has been given to individual productivity improvement projects.

Programs to encourage participation by all employees. Quality circles; task forces; emphasis on specific areas, such as white collar productivity and automation, followed by widely attended conferences to discuss programs and results; and efforts to communicate more about competition and the business environment are examples of steps taken.

Says Murrin: "Westinghouse has established productivity improvement as a critical objective for all our business units. As part of our near-term productivity improvement effort, we plan to concentrate attention on improving communications and people management—and on applying technology in the office to help improve white-collar productivity."

American Productivity Center Approach

The American Productivity Center in Houston, Texas is a privately funded, non-profit organization, headed by Dr. C. Jackson Grayson, Jr. It is dedicated to strengthening the free enterprise system by developing practical programs to improve productivity and the quality of working life in the United States. It has embarked on a major project called IMPRINT: IMprovement of PRoductivity with INformation Technology, which has as its goal the identification of techniques for using advanced technologies to improve the productivity of knowledgeable workers.

According to American Productivity Center officials, IMPRINT is a five year program in which sponsors will participate with APC personnel in joint research efforts. A new building is under construction and, when completed, it will contain equipment valued at approximately $1,500,000 plus time-shared access to other facilities, making it the largest test bed in existence for productivity research on information technology.

Individual segments of the research program are expected to require much less than five years to complete, particularly the measurement and behavioral areas. The research into the overall organizational impact of technology will be much longer. The five year duration of the project reflects the fact that technological developments in office systems are at an early stage and many changes are expected to occur in equipment types and capabilities throughout the 1980s.

grams to office technology specialists—managers of data processing, or telecommunications or administrative services or whatever. As talented as such personnel may be, if they are given the assignment because of the technology involved, they will address the effort as a technology project. However, improving office productivity is a business problem, not a technology project. It must be dealt with as such, if meaningful advances are to be made.

The office is a people place. It is populated by people today and will be in the future. Consequently, any program to introduce new technologies into the office must concern itself with the behavioral implications of such an effort, especially to the extent that the technologies affect managers and other knowledge workers.

For example, the installation of computer-based systems to handle payroll, billing, accounts receivable and similar applications has had little effect on office workers, other than at the clerical level. Such systems move routine processing from the office to the datacenter. The work left in the office is limited to the handling of input to the system, output from it, and exceptions. As a result, today's office workers have interfaced only minimally with technology. The actual interface occurs among the technicians at the datacenter. That will not be so in the Office of the 80s, however. Almost every advance being made in office technologies assumes that office workers, at all levels, will interface directly with modern office equipment. Any plan calling for the introduction of such technologies must give serious consideration to the behavioral implications of that interface.

Realistically, a comprehensive program to use technology to help improve office productivity must have strong, continuing support from senior management. Otherwise, it will founder and eventually lose its impetus and direction.

How can new office technologies improve office productivity? The first way is in providing tools to streamline the processing and communicating of information—the basic functions of the office. Without attempting to be definitive, one might look at some of these tools and their usages, within that context. In the paragraphs that follow, the equipment discussed and the capabilities described are in use today. Tomorrow holds the promise that these capabilities will be enhanced even further.

Data Processing

The most widely known office technology is data processing—the use of electronic computers to gather, manipulate, record, summarize and report on the volumes of data which flow through an enterprise. The large data centers, serving a variety of users, which developed in the 60s, have been supplemented in the 70s, and sometimes supplanted, by minicomputers—small, relatively inexpensive and powerful computing devices which bring computing capabilities closer to the user.

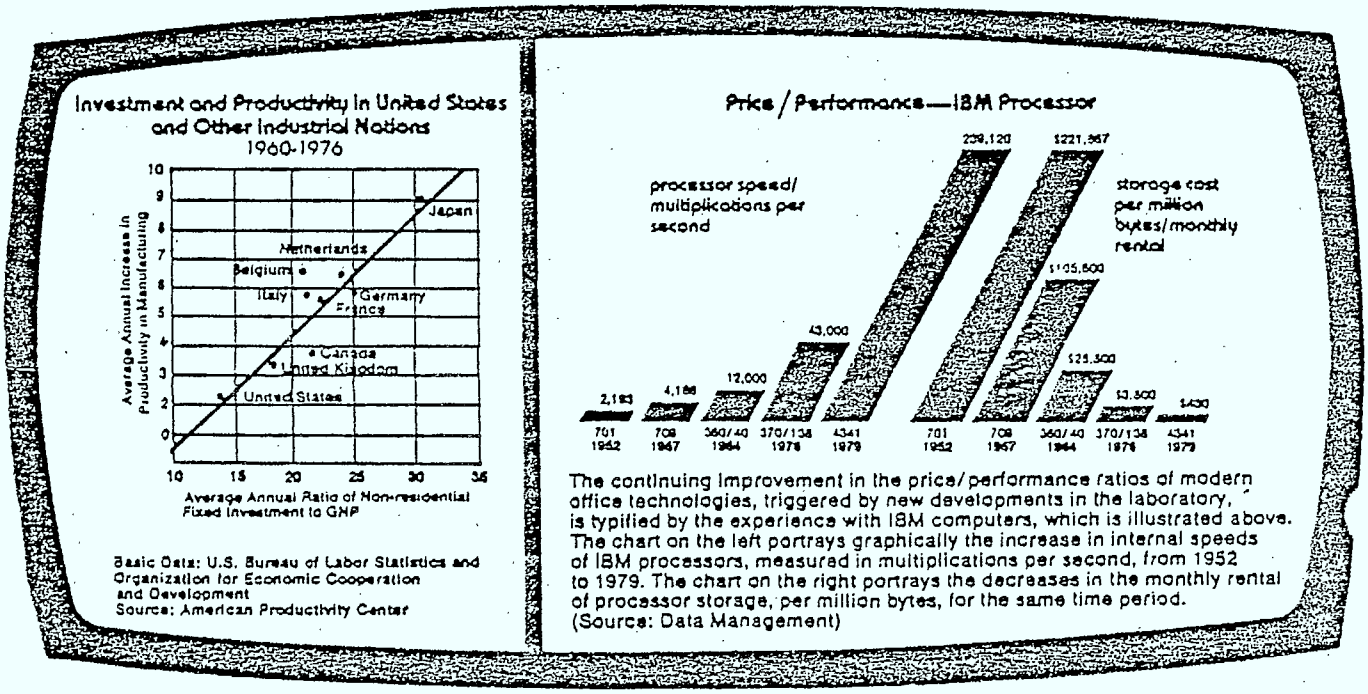
The number of applications that have been developed for the computer, in its various forms, is almost beyond belief. Computers are an integral part of business operations and many businesses—credit card processing, airline reservations, check handling—could not exist in their present form without computers. As time goes on, every office machine will have a computing capability built into it—an ability to manipulate, store and move information, under programmed control. A computing capability is rapidly becoming as common as electrical power and almost as easily obtainable.

Word Processing

Perhaps the second most widely known office technology is word processing—the use of sophisticated machinery to facilitate the production of typed correspondence and reports. Early machines were stand-alone devices, with limited storage capacity. They proved most effective in the production of personalized form letters and other material which contained standard paragraphs selected from storage. Later developments included improvements in storage media and capacity, plus the ability to share control facilities and printers. The most powerful development in word processing has been the introduction of a screen on which typed text appears for editing.

The economics of word processing equipment versus typewriters can be challenged, for straightforward, one-time typing. However, if revisions in material have to be made, the equipment pays for itself many times over. Once material is entered into a text editing word processor, it is stored in memory. If revisions have to be made, the stored material can be brought up on the screen without re-keying, changed as desired and an edited copy produced. The public relations manager with last minute changes in a press release, the lawyer revising a contract, and the analyst finalizing a report can all attest to the benefits of text editing word processors.

In recent years, a communications



The continuing improvement in the price/performance ratios of modern office technologies, triggered by new developments in the laboratory, is typified by the experience with IBM computers, which is illustrated above. The chart on the left portrays graphically the increase in internal speeds of IBM processors, measured in multiplications per second, from 1952 to 1979. The chart on the right portrays the decreases in the monthly rental of processor storage, per million bytes, for the same time period. (Source: Data Management)

capability has been added to word processing equipment so that material typed in one location can be printed out in another. A number of companies have now installed such machines in worldwide networks and have thereby introduced a form of electronic mail which interconnects their far-flung operations.

Word processing was the first office technology to affect managers personally. When the equipment was originally introduced, it was accompanied by a recommendation that the secretarial function should be reorganized to separate typing activities from other secretarial activities. The former were turned over to a centralized group using word processing equipment. The latter were assigned to so-called administrative support personnel. In the process, the managers affected had to give up their secretaries.

The resistance was strong and vocal, and early installations had a difficult time gaining acceptance. However, as experience with the technology grew, new approaches were taken which paid better attention to the behavioral effects of its use. Nowadays, the benefits of using word processing equipment are highly evident and well accepted.

Micrographics

Some of the most exciting developments in office technology have occurred in the field of micrographics. The substitution of microforms for paper in records storage is a well-established practice. Microforms in such usage are economically attractive, legally acceptable and operationally desirable. They produce extraordinary space savings, permit rapid access to archived records and have a degree of permanence unsurpassed in other mediums. Every good records management program uses micrographics technology.

The exciting change that has taken place is that microforms have now become operating mediums—alternatives to paper for recording operating information. The change has resulted from a development called COM—the ability to record computer output directly onto microforms, rather than print it out. Data processing managers are painfully aware of the amount of paper spewing out of their computers. Paper costs are rising and there are physical problems in handling it. In addition, data processing managers suffer from continuing criticism emerging from the executive suite—that management is being inundated in paper. As a result, they have responded very positively to the attractiveness of COM versus paper and have instituted programs to substitute microform output for paper, wherever possible. COM equipment operates substantially faster than computer printers, and produces output which can be reproduced, moved and stored much more economically. Studies indicate that savings in excess of 90% can be achieved by substituting COM for regular computer printout.

The potential use of micrographics has been enhanced by the parallel development of alternative microforms and convenient packaging such as cartridges and cassettes. The traditional roll microfilm has been supplemented by film jackets, aperture cards, and, most importantly, microfiche. Microfiche is a 4" x 6" card-like piece of film on which can be recorded 270 or more standard size computer pages of information. It can be produced by COM and other camera equipment, easily reproduced, mailed, carried on one's person and discarded when its contents are no longer timely. Information on microfiche can be read on the screen of a very inexpensive reader and if desired, it can be enlarged to original size and reproduced on paper. The potential of microfiche has been barely scratched and it promises to be an especially important storage medium in the Office of the 80s.

A major consideration in an information storage medium is the ease with which specific information can be found. One need only consider the problems often encountered in locating a letter in the files to appreciate the importance of easy accessibility. Computers assign addresses to stored information, and once the address is entered, the information is found essentially instantaneously. Word processing equipment uses a similar technique.

Over the years, a variety of approaches have been used to facilitate the location of specific records stored on microforms. The most recent of these, and the one with the greatest potential for the 80s, results from an interface of two technologies—micrographics and computing. It is called computer-aided retrieval or CAR, and it capitalizes on the strong points of the two technologies—the ability in micrographics to store images on microforms at very low cost, and the ability in computing to have machines making logical decisions under programmed control.

In a computer-assisted retrieval system, an index to information retained

National Micrographics Association Approach

The National Micrographics Association is the clearinghouse for information and documentation on the advantages of micrographic information handling systems in many applications such as banking and finance, utilities, governments, engineering, libraries, health and medicine, insurance, education, retail and wholesale operations. In addition to its comprehensive array of publications, NMA sponsors national conferences, expositions, meetings, standards committees, and serves a network of forty-six chapters throughout the country.

The NMA has been concerned for some time with the problem of how to improve white collar productivity. In fact, its 1980 Conference and Exposition, to be held in New York April 21-25, has as its theme: FOCUS ON PRODUCTIVITY. To address the productivity question, NMA formed an Office Productivity Council which has been studying the potential productivity improvement that could be gained through capital investment in information management technologies. Working with the American Productivity Center, the Council adopted the Nominal Group Technique to help identify productivity improvement opportunities and is conducting a series of case studies to determine the actual productivity impact of information technologies.

The Nominal Group Technique stresses the importance of using groups of employees in productivity improvement efforts. It also recognizes that normal group dynamics can hinder the development, presentation and acceptance of good ideas in a free flow exchange. It therefore advocates usage of a series of procedures—silent generation of ideas in writing, round robin feedback from group members, discussion of each idea and individual voting using mathematically devised rank-ordering—to facilitate group interaction.

NMA is using its headquarters staff in its first application of the technique, with the goal of uncovering opportunities to apply advanced office technologies in its internal operations. The Office Productivity Council plans to add other groups to the project and then produce a case study notebook, detailing its findings, to help other companies carry on similar efforts.

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in microforms is stored in a computer. The index may be introduced from external sources, or it may be generated by the computer, frequently as a by-product of a COM operation. When information stored on microforms is needed, the index is reviewed on the screen of a computer terminal and the location address of the microform record is determined. The system makes full use of the computer's ability to scan the index rapidly, make logical decisions, and search on several parameters.

Once the microform address is known, the record can be found and brought up on a screen manually or automatically. The manual approach is similar to that used in standard microform retrieval. In the automatic approach, the retrieval is carried out under control of the computer or in an off-line automated retrieval system.

Some systems use separate terminals, one to view the computer-based index and the other to view the microform image. Others combine both functions in a single terminal. As will be discussed in later sections, COM, which produces computer output on microfilm with computer-generated identifiers, and CAR, which permits filmed documents to be located automatically by using those identifiers, are among the most important developments in office technology for the Office of the 80s.

Reprographics

Management has many constituencies —employees, stockholders, customers, vendors, regulatory agencies, special interest groups and the general public. To reach these constituencies and get its message across, management has turned increasingly to the use of printed matter. As a result, many companies have developed in-plant printing facilities to input, edit, photo-compose, and print a wide array of pamphlets, booklets, brochures and other well-presented, graphically attractive, message mediums.

These facilities have developed independently of other office technologies and might have remained separate, were it not for several recent technological developments. The first of these interconnects word processing equipment to photocomposition equipment. Material to be printed can be entered and edited on the word processing equipment and then transmitted to the photocomposition equipment for plating and subsequent printing. Thus, the re-keying previously involved in submitting material for printing is eliminated.

The second development is the so-called "communicating copier," which can be interconnected to computers and to word processing machines. Information from either of these sources can be transmitted to the copier, formatted using selectable type fonts, inserted into a copier-generated form if desired, printed at high speeds on paper or recorded on microforms.

Thus, information flowing through the office can be assembled, edited and printed in any way desired, using various combinations of office technologies. Reprographics will be an integral component of the Office of the 80s.

Conferencing

Managers spend much of their time in meetings. Any approach which will make meetings more effective will be a boon. A number of technologies have been developed with this goal in mind. One example is the progress being made in improving audiovisual support for conference rooms, through multi-image, rear screen projection systems using minicomputers for program control. Another approach uses machines with graphics generation capabilities to present computer-stored performance information in chart and graphic form. Still another uses video to present material. Many companies use a combination of all three.

Other efforts to improve meetings are aimed at facilitating the conduct of meetings when the participants are in separate locations. Grouped under the term teleconferencing, they include audio conferencing, videoconferencing, and computer conferencing. In audio conferencing, the participants are in separate locations connected through audio facilities. They can converse but cannot see each other. In videoconferencing, the meeting participants can see each other on television monitors, either in full motion or, if the less-expensive still frame technique is used, in a series of individual pictures which change at ten to fifteen second intervals.

Computer conferencing is quite different. The meeting participants communicate through computer terminals and their statements and questions are stored in computer memory as a continuing dialogue. Participants can share in the dialogue at any time, regardless of whether others are taking part or not. Thus, the meeting is continuous, one can participate on a time table of one's choosing and the computer contains a complete up-to-date record of all statements, questions, and responses. Computer conferencing has proven especially effective in project management where the project team members are in diverse locations and need to stay abreast of what other team members are doing.

As with many of the newest office technologies, the future of teleconferencing depends not on the technology but on the behavioral implications of its

Interfacing Technologies at The Congressional Research Service

The Congressional Research Service, a department of the Library of Congress, is designed to serve the research needs of the Legislative Branch of the Federal Government. The CRS receives more than 300,000 requests for information from members of Congress each year and approximately 100,000 require original research and production of typed reports. Most of these responses are unique and original, heavily footnoted, and revised and reworked several times before the final copy is given to the requestor. CRS has been using word processing equipment since 1973 to handle these reports, with great success.

However, two needs have become apparent. The first is that files of these paper reports are taking up valuable space; maintaining them in microfilm storage would be much more cost effective. The second is that information in the reports may have to be re-introduced into the word processing machines at a later date, an effort that requires substantial re-keying. These needs have now been met by interfacing several technologies. The reports are written by the word processing machines onto magnetic tape which is then processed through a COM unit to produce the report, in microfiche form, using a machine-readable type font. The fiche are used to replace the paper files, thus accomplishing the desired space savings.

Later, if machine access is needed to some of the information in a report, the desired pages are located on the fiche and converted to paper. The paper is then processed through an optical character reader which reads the information and transmits it to the magnetic storage of the word processing machines, without rekeying.

Thus, by interfacing several technologies—micrographics, word processing and optics—the CRS has come up with an economically attractive and operationally effective solution.

use. It can reduce the need to have people travel long distances to attend meetings, but few believe it will ever be a complete replacement for face-to-face business meetings.

Telecommunications

One could go on at length about the developments in telecommunications technology that will affect the office—computerized switchboards, voice message systems, packet switching, and fiber optics, to name just a few. The key development, however, is summarized in a word that appears several times in the foregoing paragraphs—interconnect. The basic trend, in the Office of the 80s, will be to interconnect technologies through telecommunications. Most computer systems of any size are now telecommunications-based; word processors communicate with other word processors and with computers, photo-composers and copiers; microforms and paper can be transmitted over telecommunications networks; teleconferencing is telecommunications-based as are all forms of electronic mail; and so on. The basic underlying technology in the Office of the 80s is telecommunications and over time, virtually every office machine will be interconnected to telecommunications networks. Thus, information entering the network through any one machine can be moved and made available to any other machine without re-entry.

The other word of growing importance in the preceding paragraphs is interface. Technologies are beginning to interface with one another and the synergistic effects can be especially valuable. The interface of computing and micrographics technology through COM and CAR equipment, the interface of word processing and reprographics through photocomposition and the interface of micrographics and telecommuncations in facsimile transmission networks all offer great potential for the future.

Productivity Strategy Step #4: Share Views And Experience With Others

Sharing

Today's technologies offer a number of capabilities which aid in the processing and communicating of information. A well-managed productivity improvement program should accelerate efforts to use these capabilities extensively. In this special advertising section, a number of examples are given of modern office technologies in action. These examples have been selected to illustrate the interconnection of technologies and the potential, as will be discussed below, of image-based systems. The sharing of such experiences is a key element in planning for the Office of the 80s.

The Nemesis: Paper

New office technologies facilitate the processing and communicating of information. Of far greater importance in the long run, new office technologies offer the potential of confronting head-on the nemesis of office productivity—paper. In spite of all of the advances in office technologies to date, the basic medium for recording, storing, moving and communicating information is still paper. It is the most expensive medium one could select—expensive in itself and expensive in its use. American business currently has more than 324 billion documents to deal with, and each year another 72 billion are added to the pile. Rather than reduce paper usage, such technologies as computers and copiers have been prime factors in increasing its use. Participative management, the desire to keep everybody informed and other modern management practices have had a similar impact on paper use.

Even more staggering are the costs of moving paper, of filing it and later, of finding it. A simple example will suffice. A large, well-managed firm studied its correspondence system. The study revealed that 70%-75% of all correspondence in the firm was internal; that nineteen copies were made of each piece of internal correspondence, on the average; that these copies were physically distributed through internal and external mail systems to destinations all over the world; that all nineteen copies were physically filed; and that less than 5% of the filed copies were ever looked at again. The findings are not out of line. Similar studies by other firms have uncovered equally startling statistics. The cost reduction potential of any approach that will significantly reduce paper creation, paper movement and paper filing is probably greater than the savings associated with any other effort one could undertake in an office.

Images

In confronting the paper problem, senior management should actively support programs and techniques to reduce the number of copies produced and the number of files maintained. Such efforts can achieve meaningful results. Realistically, however, paper dies hard and the most viable way to reduce paper usage significantly is to replace it with a more efficient and economically attractive substitute. Modern office technologies offer such a substitute in the form of an image on a screen—document images which can be read visually, moved electronically between machines over telecommunications lines, filed in image form under machine control, and retrieved in image form, at will, for subsequent usage.

Productivity Strategy Step #5: Substitute Screen Images for Paper

Every study to date of future office operations indicates that substantial opportunities for improving office productivity lie in the substitution of screen images for paper wherever possible. Clerical office worker productivity is improved by reducing paper filing and look-up activities and similar routine tasks. The time saved can be devoted to absorbing workload increases, without adding to the work force. Knowledge worker productivity is improved because image-based systems can provide essentially instantaneous access to a variety of information sources. Managerial productivity is improved through the speed-up in information flows inherent in image-based systems, which can improve responsiveness to changing business conditions.

The strategy, then, to improve office productivity through technology:

Price Patterns of Paper
1976-1979

Year	Paper Type	Price Per Sheet	Price Per 1,000 Sheets	% Change
1976	Continuous Form	$.0032	$3.20	
	Cut Sheet	.0030	3.00	
1977	Continuous Form	$.00325	$3.25	2%
	Cut Sheet	.00313	3.13	4%
1978	Continuous Form	$.0038	$3.80	17%
	Cut Sheet	.0035	3.50	12%
1979	Continuous Form	$.0043	$4.30	13%
	Cut Sheet	.0041	4.10	17%

Source: INTERNATIONAL DATA CORPORATION

should concentrate on introducing equipment, systems and techniques which substitute screen images for paper. The choice of physical medium used for the image is secondary to establishment of the principle that a screen image is to be employed, wherever possible, in place of paper. Once that principle is established, the somewhat technical question of the appropriate image medium can be evaluated. There are two primary candidates, each with an array of hardware and software in support—microform storage and magnetic storage. In the future, there may well be more. One of the more intriguing is the video disk and there is little doubt that some version of it will eventually find its way into the office. However, the characteristics of video disks, their ultimate legal acceptability and the ways they might interface with other office technologies are still to be determined. In the here and now, microform storage and magnetic storage are the proven technologies.

Legal Implications

Efforts to store business information on mediums other than paper, such as microfilm or magnetic tape, must have the assurance that the processes by which these mediums are created are acceptable to the courts. The Internal Revenue Service has been supportive of such efforts and generally will accept machine records, if their accuracy and completeness can be verified through audit.

According to Robert F. Williams, president of Cohasset Associates, Inc., a Chicago-based micrographics and records management consulting firm, courts and regulatory authorities are generally satisfied that microfilm copies of business records are accurate, reliable and trustworthy. However, at the present time, they do not accord the same privilege to computer-generated information and computer output is not universally accepted as evidence.

The problem is the difficulty in showing that computer-generated information is authentic and reliable. This problem of trustworthiness principally manifests itself in three ways:

1. It is virtually impossible to detect the manipulation of electronically stored data. As a result, substantial doubts can be raised about both the accuracy and the completeness of evidence which has been generated by a computer.

2. The potential for selective retrieval of data from computers poses a major problem with respect to the completeness of computer-generated information. The very flexibility and selectivity that makes electronically stored data appealing for general business purposes raises significant legal questions regarding the completeness of the proffered evidence.

3. The accuracy of the computer information is as contingent upon the equipment and the programming as the accuracy of the raw data itself. Since the integrity of the processes by which computers produce information is not always self-evident, computer submissions usually must be supplemented by the complex testimony of technical experts.

There also can be an additional problem with computer printouts since they are seldom generated at, or near, the time of the transaction or event that is the subject of the record, as required by certain evidential laws. It is therefore necessary to establish through testimony that the information was entered into the computer at, or near, the time of the transaction or event.

Williams, who is the editor of the recently published book, *The Legality of Microfilm*, points out that, in marked contrast to the problems associated with submitting electronically stored information into evidence, it is significantly easier to submit microfilm documentation. Business records retained on microfilm are admissable in all courts, although some jurisdictions have more stringent technical or operational requirements than others.

He states further that his legal research study found no instances where the accuracy, reliability or trustworthiness of the microfilming process was questioned in any of the more than 750 state laws dealing with microfilm, the 50 state insurance departments, or the 46 federal regulatory authorities included in the *Legality of Microfilm* study. Williams has concluded, therefore, that, "Of the three primary mediums for information storage—paper, microfilm and electronic—microfilm copies are intrinsically the most trustworthy, since microfilm is the medium most resistant to alteration. Further, the process of microfilming has all of the generic accuracy and completeness of photography."

Microform Storage

Microform storage includes roll microfilm and microfiche, plus related mediums. Information recorded in computers and in word processing equipment is converted to microform storage using COM equipment, as described earlier. Information recorded on documents is converted to microform storage by recording the documents photographically on film, at greatly reduced size. Information in microform storage can be retrieved using a computer-generated address or other identifier and displayed on a screen. It can be printed out or it can be converted to magnetic storage using computer input from microfilm (CIM) equipment.

Magnetic Storage

Magnetic storage includes tapes, disks, diskettes, core, and a variety of other devices in which information is stored in digital form. Computers, word processing equipment and many other technologies use magnetic storage in the processing, retention and movement of information. Information enters magnetic storage by keying, through optical or magnetic character reading devices, or from other machines. Once in magnetic storage, information can be manipulated and moved at high speeds. It can be retrieved, using a prescribed identifier, and displayed on a screen, or it can be printed out at high speeds. Alternately, using COM equipment, it can be converted to microform storage.

Operating Considerations

In addition, the strategy must recognize that the unalterable nature of the record in microform storage, which makes it legally attractive as a substitute for paper, may or may not be acceptable from an operating point-of-view. For example, an addressee wishes to see incoming letters in toto—the letterhead, the body content and the signature. However, there is no need to alter or manipulate individual elements of the letter. Therefore, a photographic copy of the total letter can be a viable substitute for the original, from an operating point-of-view.

An incoming invoice, on the other hand, has different operating requirements. A photographic copy is not suf-

ficient because there is a need to address and manipulate individual elements within the invoice—to verify the date and amount, check against other records and so on. To accomplish this by machine, the information on the invoice must be entered into magnetic storage for processing.

Economic Considerations

Thus, the strategy to substitute screen images for paper must look at the alternatives of microform storage and magnetic storage in terms of legal implications and operating requirements. In addition, it must consider economics. In so doing, another factor enters the equation—speed of access. How quickly is information needed? Instantaneously, in one second, in five, in an hour, in a day? The general rule in office technology is: the faster the access required, the higher the cost. For example, information stored directly in computer memory is available essentially instantaneously; disk-stored information takes somewhat longer, although still very fast; while a measurable drop-off occurs in retrieving information from magnetic tape. Cost analyses reflect these differences; computer memory costs more than disks which, in turn, cost more than magnetic tape.

With modern computer-aided retrieval equipment, information in microform storage can be accessed very rapidly, although not as rapidly as information in magnetic storage. However, microform storage, and all the equipment used to support it, costs substantially less than magnetic storage and its associated equipment. As a result, there is an economic trade-off involved, which is portrayed graphically in the accompanying box.

Analysis of the trade-off suggests that the strategy for storing information should call for the use of the more economically attractive storage medium—microforms—as soon as access requirements are met. Astute systems designers recognize this trade-off and apply it today in their design of new systems.

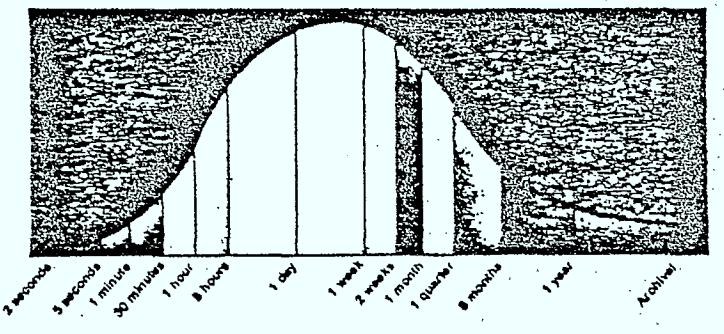
From an operating and an economic point-of-view, then, a strategy to substitute screen images for paper should use an optimal combination of microform storage and magnetic storage to support image-based systems.

Equipment

Managers concerned with using modern technology to improve office productivity face a fascinating array of options. The numbers of machines on the market, the different features which each offers and the continuing improvements being made in product lines present a greater variety of alternatives than has ever been available in the past. Further, the traditional dividing lines among technologies are beginning to blur, as exemplified by word processing machines taking on data processing capabilities, and vice versa, and microform images co-existing with magnetic images in the same systems. Office technologies will continue to evolve throughout the 1980s, as the power of chips, lasers, fiber optics, bubble memories and other technological innovations are applied to office needs.

Productivity Strategy Step #6: Understand Office Technologies Conceptually

At the same time, it is very easy to become mesmerized by future technologies and what they will do, and spend one's time speculating on what the future office will be like. Popular literature often features Buck Rogers-like descriptions of the wonders of tomorrow's office. The goal, however, is to improve office productivity; and technology, stripped of the whistles and bells, is a set of tools which can help in achieving that goal, specifically by substituting screen images for paper. The effective manager will find that by looking at technology in that very practical light, a strategy can be developed to employ the capabilities of technology in optimal fashion. The details of the strategy can be worked out with office technology specialists from data processing, telecommunications, micrographics, word processing, records management, administrative services and other disciplines. The overall strategy should be based on a conceptual understanding, first, of what machines



The trade-off between speed of access to information and cost of access to information cannot be determined by some hard and fast rule. Rather, it must be analyzed on a case by case basis. Some of the factors which should be considered in the analysis are illustrated in these charts.

The chart above shows a typical information curve versus time. A relatively small amount of information is needed in seconds or minutes, increasing amounts are needed in hours, demand peaks between a day and a week, and so on. The difference in the time required to access information in microform storage, as opposed to magnetic storage, is rapidly decreasing, especially with the advent of computer-aided retrieval equipment. So is the time required to update retrieved information. The shaded area under the curve indicates microform updating time versus information time demands.

The relationship between microform and magnetic storage is changing as a result of developments in both fields. It is being tracked carefully by the best systems designers because of the economic differences between the two. The chart below provides a snapshot of these differences. It shows the comparative costs, in cents per standard size page, on a fully burdened basis, of moving, storing and retrieving information.

Comparative Costs
Microforms versus Magnetic Storage
(Cents/Page)

	Microforms	Magnetic Storage	% Microforms Over Magnetic
Distribution	.3	124.0	413%
Storage	.00002	.012	600%
Retrieval	1.0	8.4	840%

Source: The Journal of Micrographics

can do to substitute screen images for paper; second, how they function, in principle; and third, what operating and economic ramifications are associated with their use.

The Payoff

Prior paragraphs have discussed how information is converted initially into microform storage and magnetic storage, so that it is available as an image on a screen. Converting information to an image form is an investment. The payoff begins when the images are moved, stored and retrieved. Consider the typical mail system that has been converted to an image-based system. Mail from external sources has been microfilmed upon receipt. It is brought up on a screen by the addressee, using a computer-aided microfilm retrieval system. Internal correspondence stored in magnetic form by word processing equipment is brought up on a screen in similar fashion. Responses to both are entered into word processing equipment which delivers the internal response electronically, in image form, and the external response in letter form. At an appropriate interval, letters stored in magnetic form are converted to less expensive microforms, with an identifier attached to permit rapid retrieval, if necessary.

Now, such an approach to a mail system may have rough edges which require smoothing. Also, there certainly are different procedures one could follow. The bottom line, however, is that, other than the first step, when incoming letters were converted to a microform, and the last step, when outgoing letters were printed by word processing for mailing, no piece of paper was created, or moved, or filed or retrieved. The entire process took place under machine control, using images on a screen in place of paper, at speeds far faster than possible heretofore, without diminishing the addressees' access to information or their ability to respond.

Expand the approach one step further to provide screen access to current information in computer data files; to less frequently accessed information in microform storage; to systems capable of generating graphic portrayals of computer-based information, to library material in microforms, and the power and potential of image-based systems to increase office productivity begin to emerge. Such systems improve clerical productivity by eliminating expensive, time-consuming tasks such as excessive copying, maintenance of multiple files, searching needlessly for file information, and overloading the mails. However, the primary beneficiary is the manager and the knowledge worker, whose access to information and capability for timely response are enhanced to an extraordinary degree.

As discussed earlier, the viability of image-based systems and their usage to reduce paper depend on the legal acceptability of substituting an image medium for paper. At the present time, microforms are the most readily accepted substitute. Fortunately, there have been a number of breakthroughs in micrographics technology, in parallel with developments in other technologies, which lend assurance that a reasonable combination of microform and magnetic storage can be incorporated into future systems to meet legal, operating and economic requirements. As mentioned before, equipment is now available in which computer technology is used to aid in retrieving images from microform storage. Microform images can now be transmitted in facsimile form or digitized for input to computer systems or transmitted digitally. Also, microform images can coexist with images from magnetic storage in the same machine and, as a matter of fact, on the same screen. The trend is clear. A legally acceptable and operationally viable image-based capability will be available, when needed, to support the various information systems used in the Office of the 80s.

Printing

Like it or not, the office will never be free of paper. What image-based systems can do is reduce the amount of paper used. Eventually, however, machine-stored information must be printed out—paychecks, invoices, letters, reports, etc. Modern office technologies provide a variety of printing capabilities. High speed printers, both impact and non-impact, produce a continuing stream of reports from computer systems. Word processing machines can print letters and reports at high speed, with typewriter quality. Both computers and word processors can transmit information to communicating copiers which print information in selectable type fonts. Word processing equipment can transmit information to photocomposition equipment for inclusion in printed matter.

Here again, image technology plays a role. Rather than produce computer reports in printed form, the reports can be recorded on microfiche, distributed, used while current and disposed of when out of date. Computer generated graphic displays can be converted to 35MM slides or to color photographs. Although not all-inclusive, there are alternatives to paper in almost every aspect of office information systems.

Accelerating Information Flows

All of these efforts to streamline office operations by substituting screen images for paper have a common characteristic—they speed up information flows. Information is the lifeblood of any organization. It is the reason why the office exists in the first place—a facility for processing and communicating information.

The prime information communicators in offices are managers. They gather both hard and soft information from many sources, synthesize it, add their own input and communicate the results—a new strategy, a directive, an observation, an approval or whatever. Image-based systems which speed up information flows affect managers directly, as they carry out their managerial duties.

The emphasis is not necessarily on making managers more efficient, although such is often the case. These

Interfacing Technologies at Exxon

Exxon has combined the use of microfilm storage and magnetic storage in several key company components to streamline the handling of incoming correspondence. Before reaching the addressee, an incoming letter is indexed, abstracted and the abstracted information entered into magnetic storage. The letter is then recorded on updated microfiche, and forwarded, along with the fiche, to the addressee.

Every subsequent piece of incoming, outgoing or internal communication related to that document is added in abstract form to magnetic storage, and as a complete image on the updatable microfiche. Thus, each incoming letter goes to the addressee accompanied by a fiche of all the correspondence to date pertaining to the subject of the letter.

At any time, then, an Exxon executive can call for the complete file on a given project by calling up the abstracted information from magnetic storage or the complete pages from microfiche, and viewing the file on a screen. Further, microfiche copies of correspondence abstracts on any subject are distributed to every executive on a regular basis.

systems can make managers more effective and more productive by providing them with a continuing stream of timely information, from a variety of sources, in convenient form, which can be accessed on a terminal from the office, from home or while traveling. Although systems which substitute screen images for paper have great potential for cost reduction, their ultimate and most far-reaching benefits may well lie in their ability to help managers manage more effectively.

Productivity Strategy Step #7: Recognize the Behavioral Implications of New Technologies

People Issues

Consideration of the possible impact of image-based systems on managers raises the question of the level of managerial acceptance of such systems. It is in this arena, rather than the world of technology, where the greatest problems arise. As was learned the hard way in the introduction of computer systems, and more recently with word processing systems, and as is being experienced today in initial efforts to introduce image-based systems, managers resist technology. They do so because they perceive machine-based systems to be rigid, structured, unforgiving of errors, and unresponsive to changing business conditions. Unfortunately, their perception is often true. Systems in the past have usually been designed to make the processing machinery run more efficiently rather than respond to the needs of users. Today's systems efforts are tarred with the same brush.

If efforts to improve office productivity are to be successful, and especially if inroads are to be made in the fertile area of managerial productivity, then resistance to technology must be overcome. If managers and other knowledge workers refuse to interface directly with image-based systems, or treat such systems with benign neglect, then the whole productivity improvement effort will go for naught.

What has to be done to overcome managerial resistance to technology is to include in one's productivity improvement strategy the principle that new systems will be designed to fit people requirements rather than vice versa. This principle runs counter to the schooling of most systems designers, who have been trained to design systems which optimize the efficiency of processes and the operation of the machinery used in those processes. It also runs counter to the thinking of many equipment designers who prefer standard, off-the-shelf products which run faster or have more capacity than competitive products, rather than machines which can be custom-designed to fit user needs.

However, if office productivity programs are to succeed, managers, rather than technicians, must play a key role in identifying needs. Systems must be flexible enough so that managers, as users, can decide the extent to which they choose to participate, based on their perceptions of potential benefits. The syndrome that everyone must do everything the same way may lead to systems efficiency but it flies in the face of individual managerial creativity.

The solution, then, is to recognize the differences in people and design the systems in response. If managers participate in the design process by identifying their needs and reviewing alternatives for meeting those needs, they will be more receptive to using the systems. Further, as they use the systems, they will end up modifying their own behavior and seeking out additional ways in which technology can be employed to aid them in carrying out their responsibilities.

The real challenge, then, in the Office of the 80s, is not technological, but behavioral. Although there are still some gaps in technology, one can feel confident that they will be filled in due course. Based on the track records of systems efforts to date, however, far less assurance can be given that behavioral concerns will be addressed, unless senior management makes them an integral part of the productivity improvement program.

Interfacing Technologies at Citibank

Citibank, the second largest bank in the United States, has established the goal of eliminating paper from its "backroom" support operations. At the same time, it has introduced a number of quality control procedures aimed, first, at minimizing errors and, second, at improving the speed and thoroughness of responses to customer inquiries. The approach being pursued, arrived at after extensive investigation, interfaces computers, micrographics and word processing.

Incoming stock certificate exchanges, funds transfer instructions, letters of credit, loan information and a host of other transactions are recorded on roll microfilm, while an identifier for each document is recorded in computer memory. When an inquiry comes in, the investigator to whom it is assigned no longer has to search a paper file, but interacts instead with a computer memory to find an address for the pertinent document. The address is fed by the computer into a reader with computer-aided retrieval capabilities, which then searches the roll microfilm automatically.

When the image of the document appears on the screen, the investigator then addresses three questions:

1. What did the customer ask us to do?
2. What did we do?
3. What action needs to be taken to satisfy the transaction?

By means of a word processor interfaced with the reader, the investigator can then initiate any action that might be needed and communicate to the customer what has to be done.

Funded Research

In today's business world, no product of any significance comes to market without first being tested. Funds are budgeted for market research, a test market is selected, the product is introduced and its acceptance carefully measured. If sales criteria are met, the product is formally introduced; if not, it is withdrawn. In either event, funding the research is considered a good investment and the only market test considered a failure is one that does not accurately predict product performance.

The same principle holds true in the factory. No change of any significance is made in a manufacturing process without first establishing a pilot plant operation and testing the new approach. Again, funds are budgeted for such research and are considered to be a good investment.

Not so in the office, however. Few, if any, firms budget funds to test the potential and the problems associated with introducing new technologies into the office. Instead, a proposal to invest in new office machinery is subjected to a cost/benefit analysis, on paper, and a "go/no go" decision is made, based on that paper analysis. The behavioral implications, the possible effect on organization structure, the fall back position if things do not work as planned—all of

these considerations are subordinated to the dollar and cents evaluation.

There are too many unknowns in the Office of the 80s, however, and the stakes are too high to allow this practice to continue. Funds must be budgeted to bring in machines and test them, to determine how they will perform, how people will react to them, and what they will accomplish in a particular office environment. If the machines perform well, all the better. If not, they can be disposed of. In either event, the cost should be written off as a valuable investment in research. Only through such testing can management be sure that the steps being taken to improve productivity have a reasonable probability of success.

Human Potential

Modern office technologies, properly employed, can improve office productivity at all levels. In addition, and of far greater importance, they can expand human potential. Corporate planners who use computer models to test alternative business plans are not only more efficient; potentially, they are better planners because the equipment allows them to examine more alternatives than could be done by hand. Corporate librarians have the potential of being better researchers because they have access to a wider array of information on microforms than they could handle in book form. Company treasurers who use machine-aided cash management systems are potentially better treasurers because they can consider a number of alternative fund movement strategies. In each case, the technology is expanding the potential of the people using it, helping them be more efficient, more effective and more productive. In the long run, this may turn out to be the greatest contribution of the Office of the 80s to society—that technology was introduced which broadened the intellectual capacities and expanded the potential of office personnel at all levels.

Conclusion

The business problem is to overcome the rising costs of office operations by improving office productivity. It is a problem of serious concern today and, if left unresolved, of major consequence in the future. It warrants the immediate response of senior management to confront the issue of improving office productivity.

Modern office technologies, those here today and those planned for the future, offer management powerful sets of tools to use in programs to improve productivity. Through the interfacing and interconnecting of these technologies, systems can be introduced which will facilitate the substitution of screen images for paper. These systems lower the costs of processing and communicating information by reducing dependency on paper. They also speed up information flows, so that managers can be more responsive to changing business conditions.

In a larger sense, the use of advanced office technologies can expand human potential. By making timely information available, presented in a better organized and more easily usable form; by permitting the testing of alternatives; and by speeding up the process of communication and response, modern technologies can help office personnel, at all levels, be more effective contributors to the success of the enterprise.

The challenge to management is to take advantage of these developments and to marshal the talents of office personnel and the forces of technology in an ongoing program to improve productivity in the Office of the 80s.

The Case for Service Bureaus

The potential for improving productivity through technology can be very attractive, but sometimes, in smaller companies or those with relatively low volumes, the cost of the equipment becomes a deterrent. Often the features one needs, to take full advantage of the potential, are only available on larger equipment which cannot be cost-justified.

This imbalance between needs and costs usually can be resolved by enlisting the aid of an outside service bureau. Such service bureaus have existed for years in the computer field, and more recently in word processing and reprographics. They have proven to be a boon to office technology users because of their capacity for helping companies gain the efficiencies, systems expertise and economics enjoyed by their larger brethren.

This has been especially true in the COM field, because COM equipment tends to be expensive, combining as it does a number of sophisticated technologies in order to make the transition from magnetic storage to microform storage. With COM service bureaus, these costs get shared among a number of users, and each can enjoy the benefits of the most powerful COM equipment available.

Typical of such users is the Preferred Risk Insurance Company of Des Moines, Iowa. Preferred Risk personnel found that their active automobile policy files were becoming more and more difficult to work with, in handling customer inquiries. Since the major way that insurance companies remain competitive is through service to the customer, being able to offer prompt, fair and courteous claims and policy inquiry service was of the utmost importance.

A study was made to find a storage medium for the files which would help improve the handling of inquiries. One approach was to convert the files to magnetic storage, where they could be accessed by computer terminals. This approach would do the job, but the time involved in developing and installing the system and the costs attendant with its installation and use turned out to be major drawbacks.

A second approach called for conversion of the file to microfiche. Here again, however, the economics of the approach became a stumbling block. Since information was processed through a computer, the ideal way to create and update the microfiche file would be through COM equipment. However, the volume of changes could not justify installation of an in-house COM capability.

The problem was solved when Preferred Risk enlisted the aid of a COM service bureau. A system was devised, utilizing the in-house computer to write policy change information on magnetic tape; a COM service bureau to create microfiche from the tape; and in-house microfiche readers to research policy information in response to customer inquiries.

The ability to make use of large scale technology without incurring commensurate costs, by taking advantage of the offerings of an outside service bureau, has resulted in major savings at Preferred Risk. In addition, response time to inquiries has been reduced to a matter of minutes.

The Automated Office in the 1980s

A Special Report from the Business Department of DUN'S REVIEW

As we enter the 1980s, the issue of automated office management is no longer the stuff for futurists. Besides spiraling availability of high-technology office equipment, there are inescapable economic forces that are compelling top management to address the issue of the computerized office.

Improved white-collar productivity has become a key to increased profitability because there is little leeway for further blue-collar gains. According to Labor Department statistics, while industrial productivity rose 85% during the past decade, there was a mere 4% advance among white-collar workers, despite huge outlays for data-processing equipment. The shift in the work force away from industrial jobs toward office ones adds to the significance of improving office productivity.

Furthermore, today's demands for information on which to base rapid business decisions have increased so dramatically that they threaten to overwhelm conventional offices, even those with rudimentary but unintegrated office systems.

Today, business is at the threshold of enormous change spawned by the development of new technologies for distributed word processing, smart copiers, computer terminal work stations, PBX's, computerized filing and data banks, laser printing and the like. Many experts envision changes even greater than brought about by computers, akin to the advent of the Industrial Revolution almost a century ago.

Management is faced with the strategic issue of collectively committing tens of billions of dollars on the young and still evolving technology of office automation. Senior executives are asked to weigh technologies that are often not completely understood, while factoring in potentially disruptive human elements—and then decide to what extent they should commit to a relatively new office work-style.

There have been two general reactions to the challenge of office technology, both predictably extreme. The majority trend has been to wait for the emergence of time-proven office systems and technologies that present minimum risk. Unfortunately, the "if-I-wait-long-enough-it's-bound-either-to-resolve-itself-or-go-away" approach can lead to irretrievable loss of competitive edge.

The second, and far smaller, reaction falls to the "Buck Rogers" breed of executives, who are so overly enthralled with new technologies that they ignore bottom-line reality. To some degree, why investment to date in advanced office equipment has not paid more visible productivity dividends is because this group, by too narrowly focusing on equipment at the expense of integrating advances into office procedures and requirements, often created overly ambitious projects that were never completed or disappointed users or caused fiascoes where employees refused to adapt to change.

Almost everyone knows cases where high technology equipment was installed and failed dismally to live up to expectation, either in service or cost benefits—or both.

But responsible management recognizes that the office has become the logical place to look for the sort of improvement that can mean sharply increased profits. What, then, is the justification to proceed? And what are the key issues to determine before creating a corporate office automation strategic plan? These are the questions that must be addressed.

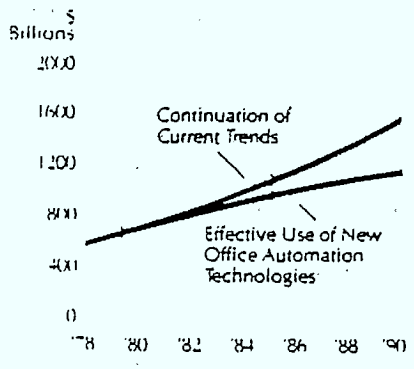
Why Office Automation?

A recently completed Booz, Allen & Hamilton study found that the white-collar work force generally is working only at 40%-to-60% of productive capacity and, perhaps more surprisingly, that senior executives commonly spend 20%-to-30% of their time on lower-level administrative or wasted tasks that automated offices could reduce drastically. Yet with the exception of data-processing and some computerized customer service systems, U.S. offices are still mired in paper-based technologies, although our country's business has become more office-oriented than ever before. What is at stake?

The investment in America's white-collar work force—ranging from board chairmen to file clerks—is enormous and growing rapidly as the U.S. economy evolves from primarily a manufacturing base to a service economy. The federal government predicts that by 1985 about one-half of an expected 104-million-person work force will be in white-collar jobs. For a nation with a farming and manufacturing base, this is a revolution indeed. The Commerce Department estimates that some 60% of the Gross National Product already involves information production, storage, transfer and utilization—clear evidence that the Information Age indeed is already well upon us.

Projected Direct Cost of U.S. Office-Based White-Collar Workers

Potential Gross Savings to U.S. Businesses—Over $300 Billion Annually



Source: Extrapolation of Historical Employment and Inflation Trend, Booz, Allen & Hamilton Productivity Estimates

An analysis of the costs of the current and projected work force shows that in 1979 U.S. business spent record sums in direct costs for front-line white-collar workers and for purchased information resources. Here are the patterns:

● *Managers.* Direct costs were reported at $240 billion in compensation and fringes. Internal support consumed another $78 billion, while purchased information resources were reported at only $12 billion. ("Only" in the sense that purchased information resources represented only 5 cents out of every dollar for compensation, fringes and 3.8 cents in terms of compensation, fringe and internal support costs.) Given the magnitude of the productivity gap among managers, the level of investment in current automated office technology to support them must be considered minuscule.

● *Professionals.* Here U.S. business reported spending $225 billion on compensation and fringes, $21 billion for internal support and a paltry $9 billion on information resources. Thus, management's investment in new electronic support technology was only 4 cents on compensation and fringe packages and 3.7 cents on overall compensation, fringe and internal support costs. Again, minimal investment has resulted in minimum impact.

● *Clericals.* The cost for the white-collar support force was $135 billion in compensation and fringes, $30 billion for internal support and $50 billion for information resources. This amounted to a far more healthy 37 cents in terms of wages and fringe benefits and 30 cents when internal support costs are added. Yet the largest investment supports the least expensive staff members. Future investment in all areas must rise by several hundred percent if the full potential of new technologies is to be realized.

Despite these staggering expenditures, most office employees believe that they are as productive as they might be. In a recent study carried out for Steelcase, Inc., 40% of those in management queried said that they are not doing as much as they can at work. The comparable figures for supervisory personnel was 44% and for "regular" office workers 35%. When asked a follow-up question whether they could do more, if work conditions and circumstances were changed, 67% of those in management said yes, while 71% of supervisory personnel and 77% of "regular" workers also said they could do more.

Some 79% of executives, managers and supervisors and 80% of professionals said productivity could be raised if the office work load were analyzed and reorganized so that work flowed more smoothly from person to person and department to department.

When queried how this might be done, 91% of the executive group said they backed investment in more computer terminals and electronic filing, typing, copying and other equipment.

Asked what was necessary for future offices, business executives gave top ranking to conversion to electronic processing telecommunications and data-processing methods. Second was the need to enhance overall functioning, while third was the need to seek better physical layouts that would positively affect employee productivity.

Yet despite the investment in labor and a clearly perceived need for productivity increases, the total investment in information resources has only reached $71 billion, which, impressive as it might seem, does not clear the threshold necessary for meaningful productivity improvement. Significantly, fully 42% of the total was for communications, while only a modest 8% was committed to record and data storage and supplies. And data processing, the "grandpa" of new technologies, got just 16% of the investment. Overall, it is clear that integrated systems with their synergistic effect on productivity have not yet been put into place in significant numbers.

Of course, many present-day office systems have at least some of the early equipment that can help boost office production. Although U.S. business is generally still mired in inefficient paper, mail and filing systems and relies on antiquated typing equipment and "dumb" copiers, there also are electronic data-processing machines, leased or owned private branch exchanges or key systems and increasing numbers of basic work processors (mainly stand-alone, single systems).

What, then, are the potential dividends of office automation for the U.S. business community? Booz, Allen research reveals that U.S. companies will spend about $725 billion in 1980 on white-collar operations. Without broad use of automated office technology, the overall cost is expected to soar to some $1.5 trillion by 1990, only a decade hence.

By adopting new technology, U.S. business can expect a productivity dividend or cost reduction of some

$300 billion annually by the end of the decade. Furthermore, top management also would be capable of far faster, higher quality decision making because of the new systems capabilities for organizing and sorting huge amounts of data at speeds measured up to trillionths of a second.

The executive charged with determining policy on automation must understand these opportunities and pressures and the four basic rationales for conversion:

● *Intensifying profit pressures.* As noted, current competitive patterns, both domestic and worldwide, and seemingly intractable productivity lags, make this the most persuasive argument for office automation. In the face of consumer and government resistance to price increases, firms in growing numbers are opting for strategies that will boost profits through cost cuts that do not translate into a weakening of either product lines or customer services. In helping to achieve this goal, office automation becomes a strategic issue as well as an operating decision.

● *Rising costs.* Conventional office support systems are not only outdated, but very cost-inefficient, a trend that is being reinforced by the same inflationary pressures that have negatively impacted profitability. Labor-intensive, relatively high-skill functions such as typing, shorthand and other office activities performed by secretaries and clerks can be largely reduced or eliminated through automation. And time-consuming professional activities, such as research or editing, also are positively impacted.

● *The professional productivity problem.* Increasingly, the drive for improved professional productivity is seen as a major priority. Management—and especially senior management—is falling increasingly behind in its attempt to make the sort of quick, effective decisions that today's economy and individual markets demand. And ever more highly paid professionals must be maximally utilized to insure highest corporate yields. On average, professional salaries account for 46% of total salary costs. As the single largest segment, their increased productivity becomes a prime target and justification for automation.

● *The high—but often intangible—penalty costs of misinformed or late management decisions.* The dangers to individuals and companies alike is most serious at the decision-making level. Even top management groups that have streamlined their decision-making process to squeeze out as much wasted time as possible find that they often are unable to meet the unyielding demands of the rapidly changing business/political world. "I'm dependent on my weekly inventory and sales figures," says a merchandiser at one of the nation's major chain store operations. "I'm dealing in millions of dollars in retail sales and have to make decisions based on what's moving and what's not. But my weekly computer reports are virtually obsolete when I get them, useless a day or two later, and I can't get another until the following week. How can I make valid decisions?"

Although difficult to quantify, the benefit of providing complete and up-to-the-minute data to professionals is perhaps the greatest profit-improver office automation will offer.

Key Planning Issues

A survey of senior U.S. executives turned up solid support for the new technologies, but industry sources say such support has yet to be fully backed by purchase commitments. Of 500 executives who responded, about half were generalists, half systems specialists. Some 77% reported they felt enhanced decision-making was a major plus for the automated office. A close second was a strong feeling that the systems would lead to important improvements in managerial and professional productivity. Stronger competitive positioning also was cited as an important reason to adopt the new technologies.

Why haven't these executives invested more heavily in office automation equipment? Lack of experience and lack of confidence were cited as the most serious obstacles. To these should be added another objection unearthed through research: the need for concrete cost/benefit data and a better understanding that currently available equipment has sufficiently progressed to warrant investment.

This concern crops up in many discussions of "what went wrong" during initial installations of office automation equipment. Early arrangements tended to favor equipment positioning over personnel placement. Work and social patterns of many years too often were scrapped to accommodate the new equipment. Much of what was installed later had to be rearranged in the wake of productivity stagnation or even losses, high job turnover, and also disaffection among the new leadership cadre that was to direct the office operations.

How Critical Is Top Management Support?

When polled, every professional in the office automation industry responded that top management support is the single most important criterion for a successful conversion.

At one Midwestern company, the president distributed a memo informing all executives that, with the installation of a PBX and central dictating and word-processing system, he and everyone else would no longer use secretaries for these purposes. He lived up to his bargain and cooperation was 100%.

A vice president in charge of implementing a conversion for one of Baltimore's major banks sees top management support as the issue critical to the success of the work: "The reaction to office automation from our top management has been outstanding. We're asking people to change. If we don't, we can't survive. We prefer to change in a planned way, rather than end up changing in a way we don't want. Support staff has been very excited by office automation and sees it as something good for them. Some principals have been threatened, but overall we have a pretty progressive attitude."

James Converse, supervisor of Office Systems Consulting Services at Eastman Kodak Co., also believes top management awareness is a critical factor in Kodak's success. He says, "Top management has a constant and continuing interest in our effort to improve productivity at all levels."

Although there is no fail-safe approach to insure a successfully de-

signed and implemented office of the future, without top management support success is doubtful.

John Blood, corporate director of Data Processing Communications at SmithKline Corp., reiterates, "Since office automation is a new strategic direction that is changing the way we do business, it's imperative that top management be involved from the ground floor up."

How Proven Must Be the Technology?

Although more is certainly to come from research and development groups working at fever pitch across the country, the fear of becoming involved in office automation too early, or of being locked into obsolete equipment, should be blunted. Pioneering is not usually profitable, but implementation must begin now. To await the perfect system, totally compatible with every other device, at the right price from the right company, is to delay forever. A start now, despite the hazards involved, will insure a smoother transition, as automation makes further advances, along with the development of a core of internal expertise that can provide a leg-up on the competition.

This does not mean that one should opt for an overnight plunge into the so-called "office of the future." Since most offices exist with yesterday's systems (or lack of them), an orderly update to the office of today makes more sense and avoids the trauma, expense and serious disruptions of an overly ambitious or perhaps too premature program.

Of course, outright purchase of equipment in a climate so volatile is rarely desirable, although some underfinanced manufacturers make their rentals virtually punitive versus relatively attractive lease/purchase plans. The cash flow and capital situation of your company is, of course, also a factor. But involvement now is *not* premature, and certainly should not be delayed any longer.

What Are the 'Backbone' Applications?

There is typically a "backbone" application that must exist to justify automated equipment within each area of a company. Most frequently, that backbone is word processing, the relatively humble task of text editing and manipulation, where productivity can be dramatically increased by automation. In promoting a recently announced multipurpose office system, for example, salesmen stressed its practicality by cost-justifying it simply as an automatic typewriter. Despite many other capabilities, Xerox's somewhat comparable 860 is also marketed in that manner.

But once the terminal is in place for word-processing applications, additional piggyback applications can add sex appeal and substantial benefits for very little or no additional cost.

At no extra charge, these piggybacked applications will complement the primary one by either creating electronic mail, filing or conferencing systems *as long as they can be justified by a backbone application.*

Electronic mail alone, for instance, is very rarely cost-justifiable except in unique, limited situations where speed and accuracy are essential. Such razzle-dazzle is attractive, but without the backbone it realistically is no more than a costly, needless toy.

How Can the Benefits Be Quantified?

Another key issue is to what extent can potential and achieved benefits be quantified. By and large, the task of quantifying clerical work has been accomplished through systems as sophisticated as MTM and other industrial engineering techniques. Secretarial productivity is somewhat more ephemeral. If a secretary receives twenty calls today, versus forty yesterday, is she half as productive?

Yet administrative support audits can—and do—quantify secretarial efficiency, typically finding cost reduction opportunities of about 20%.

If secretarial productivity quantification is somewhat difficult, it's a piece of cake compared to the issue of quantifying professional and managerial productivity, which raises far more questions as to its value or its feasibility.

Jim Converse of Kodak says, "We don't have a very clear definition of how to do it, but we feel it's imperative for justifying advanced office automation systems." A systems executive in Baltimore explains: "At our own bank, we're realizing that quantifying productivity for everyone is important the principals, secretaries and clericals. Professional productivity can be quantified probably through bottom-line measurements [return on investment, assets] as opposed to work procedures."

Howard Anderson, president of a consulting firm specializing in technology, disagrees and believes that professional productivity must be measured, but primarily in a qualitative measurement. "Management," he says, "is the art of making decisions with inadequate information, incomplete facts and insufficient resources. You never have all the information you want. That's why management is an art. Given the same amount of resources, we can have better, timely information and make more enlightened decisions."

The difficulty, of course, is in assigning a dollar value to creative and intangible activities that may or may not eventually result in tangible benefits to the company. Is a trip to a convention productive? By what standard? How far down the road will a sales call reap an order? How do the hours spent preparing for an internal meeting contribute directly to the bottom line? Should productivity be determined by the number of reports read or memos written or meetings attended? Obviously not, but finding out what to use has been difficult.

Walter Kleinshron, Editor of *Administrative Management Magazine*, comments: "It's been a debate as long

as I've been in business. You can probably get a soft measure on the productivity by quantifying the end product in homogeneous classifications." But Charles Cumston, Editor of both *Word Processing Systems Magazine* and *Word Processing Report Newsletter*, thinks it an impossible task: "So much is intangible. Any tasks at the professional level that could be quantified, professionals shouldn't even be doing. They should be creating and managing."

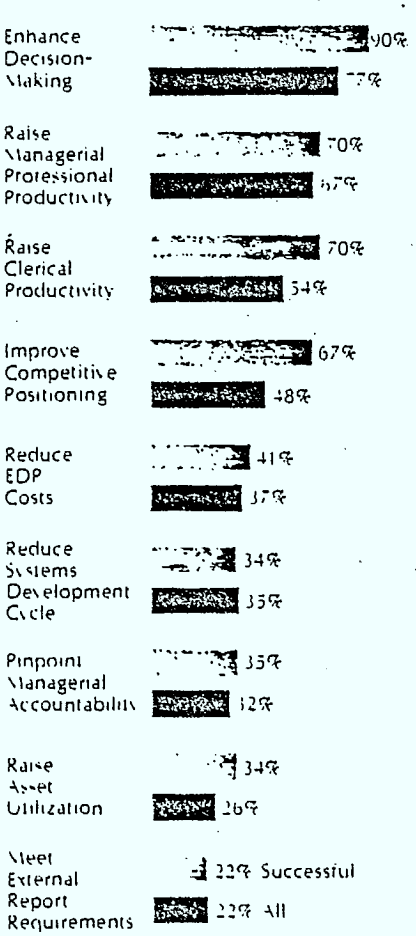
Because of such confusion and a clear need for methods by which to quantify professionals' work and then predict improvements made possible through productivity, Booz, Allen & Hamilton is now undertaking a study on behalf of more than thirty equipment vendors. The study, which covers fifteen separate offices, will present information that is more closely quantified than ever before.

In addition to clerical and professional quantification, the benefits or value of more complete, timely or accurate information must also be considered.

Putting a price tag on the speed and accuracy with which market data, government regulations, competitive analyses, sales figures, inventory *et al*, are available is difficult but can make a telling difference on the bottom line of a company.

Frequently Cited Benefits

Over 500 Questionnaire Responses from User, General and Systems Executives (6 79)



How Fast To Implement And How To Manage

A third key issue is how quickly implementation can take place within a particular company's individual environment, taking into consideration its resources, user acceptance and funding availability. These three questions are critical, and their answers will define how fast changes can be implemented.

The mechanics of managing office automation present another side to this question. In putting together a plan, one must determine:

- Size of implementation staff necessary to survey and convert a facility.
- The function of each staff member on the staff.
- Methodologies used to study, design and justify systems.
- Progress measurements and benchmarks.
- Results quantifiers.

What Are The Costs?

"How much will this cost?" is the question most frequently heard from top management, but, though certainly valid, it is impossible to answer in general terms. Costs will depend on individual needs and reflect them. As a general rule of thumb, hardware costs should be offset by labor savings within just 18-to-36 months, and frequently sooner.

Cost considerations are being helped by continuing breakthroughs in microelectronics and other technologies. Cost reductions of 85% and more are being realized, and further reductions are certain to appear as the automated office equipment continues to run counter to general inflationary trends in terms of cost efficiency. A commonly quoted insight into the situation is that if the cost of a 1955 Cadillac had been reduced by as much as that of electronic memories, while efficiency was raised to an equal degree, the Cadillac would now cost $5 and go 20,000 miles per hour. Although cost decreases most likely will begin to level off somewhat in the near future, the key to determining your investment must come from determining your applications, the value (either in cost savings, cost reductions or higher quality) of the equipment proposed and the range of prices offered by vendors.

What Is the Organizational Philosophy?

Another key issue is determining the best way to integrate your plan with the organizational philosophy of the company. Should a task force or committee be set up to assist in planning and conversion? What involvement should end-users have? Who in the firm should take on day-to-day operational responsibilities? How should such a plan be structured to insure integration with complementary functions such as data processing and personnel?

The management philosophy of a company will dictate the appropriate method of involving employees. Democratic, interactive firms typically opt for committees, with high user feedback and response, while more paternalistic firms, predictably, design a system and only then introduce it to the staff.

Analysis of individual office styles also is important. What works in New York may or may not work in Boston, but almost certainly will be totally disruptive in Tampa. The type of industry is important, too. The style of a large urban advertising agency will vary widely from that of a suburban light manufacturing facility in a campus-like setting. Careful consideration of the organizational and management philosophy and style will prevent the formulation of a heavy handed or inappropriate action plan.

The Major Risk Factors Of Office Automation

Risk factors will vary, not only from company to company, but from division to division, or even from department to department. They may include issues such as impact on unionization, loss of professional and clerical staff, trauma during conversion, among lesser concerns.

It is best to define and realistically consider these risks versus the opportunities, and once a decision has been reached, to proceed, implementing programs to mitigate the risk factors whenever possible.

How Do You Begin?

The dangers of an overly ambitious conversion have already been discussed. Because of the problems that frequently arise, it is usually recommended that both for financial and human resource considerations, companies begin automation slowly. An often suggested tactic is to install a core system that will provide one department or office with several integrated equipment installations and satellite equipment of a more limited in other parts of the company.

Such basic systems should be capable of relatively simple expansion, as more and more of the firm's information and transactions are switched from paper to electronic pulses. This sort of solution, if the original equipment is planned as cost-efficient from the beginning, can also ease financing problems that may extend beyond technical cash flow and debt considerations. Programs that are demonstrably self-liquidating can go far toward convincing boards of directors and activist stockholders of the viability of the new technologies.

The Systems Architecture

The concern that is raised by users with greatest frequency at professional conferences, seminars and on consulting assignments is always: "What equipment should we be using in automating our office?" Unfortunately, the push from vendors has focused attention on equipment, and all too often users are made to believe that it is the machines rather than the procedures that are the key to a successful conversion. Management is also intimidated by the technology and fearful of making a wrong choice.

Publicity and media overexposure, coupled with a host of manufacturers jumping into this hot marketplace, has inevitably led to confusion over the viability of the office of the future. But there is a simple trick to demythologizing the office equipment scene. When you define office automation needs by function, rather than with a hardware bias, equipment falls relatively easily into five basic categories, which can be defined as:

- *Conferencing.* Definable as the interactive exchange of information involving two or more persons at different work stations. Conferencing may directly and dramatically impact the vast amount of time and money U.S. and world business expends on meetings, which has long been the bane of CEO's and cost accountants. The simple telephone was considered too crude an instrument for complex interactive communication, and so the practice of business trips with associated jet lag and work time loss continues. One real-estate executive explains, "A deal may take a year. The intangibles in a meeting are too important to dismiss, so, I personally may attend twenty-to-fifty meetings for a single deal. But half of them are a waste of time."

  Now, viable alternatives are appearing for all but the most sensitive meetings, when face-to-face sessions are deemed imperative. Three new techniques add the all-important visual factor. This permits not only a sense of full verbal communication with the ability to watch facial expressions and body language for clues, it also allows the addition of data, documents, image and drawing displays with still-frame and slow-scan video augmentation. Equipment packages permit the transmission of data for reproduction as hard copy documents. Changes in data and decisions reached during the meeting can be incorporated into the firm's data base, updating old information and providing a permanent meeting record.

- *Information Retrieval.* The amount of time wasted by both secretaries and professionals while research is carried out is legendary. Many managers admit that the delays sometimes are deliberately extended because of bureaucratic lethargy and a too human desire to avoid coming to grips with major problems until the last minute. Getting the necessary facts upon which to make sound decisions has plagued senior management ever since the modern business world developed.

  Now, information retrieval—the easy accessing of filed or stored information—makes vast storehouses of data available through internal and external databases that can be electronically scanned. Full documentation can be summoned either on computer-driven typewriters or viewed on cathode-ray tubes. The information that management can command in seconds ranges from the usual memoranda and reports to engineering drawings, financial data and the array of information contained in external databases. Major news files have been computerized, as have storehouses full of scientific reports, legal precedents and the like.

● *Information Transfer.* This is one-way electronic transport of information among people. New desktop input/output devices, mainly computer terminals with cathode-ray tubes for display, enable users to originate, format and edit, and transmit/receive a broad spectrum of materials. Such systems cut memo travel time to seconds and allow transmittal of drawings, charts, graphs and even spoken messages. Electronic mail may be just around the corner, assuming continued deteriorization of the U.S. Postal Service and reasonably swift regulatory action from Washington regarding the legislation affecting electronic networks in competition with the Bell System.

● *Personal Processing.* This technology, in combination with sophisticated computer software, provides entry into the era of integrated information systems. Continuing breakthroughs in microelectronic circuits promise yet more impressive switching speeds—measured in trillionths of seconds—and cost reductions. Although much has been accomplished in the processing field, the full potential still is somewhere beyond current technological horizons. It can be defined as the automatic manipulation, structuring, formatting and correcting of words and numbers. Text editing is a typical personal processing function and the current single largest utilization of personal processing on the business scene today. But eventually, desktop terminals will be universally available to allow professionals to build models, create computer-assisted blueprints and perform other business functions more quickly and easily.

● *Activity Management.* Different from the other four categories, activity management is active rather than passive. Even more sophisticated than the processing function, activity management provides such service as automated reminders, screening, tickler files, project management scheduling, itinerary planning, etc.

With this sort of equipment integrated into advanced automated office systems, the system itself can take on an important role in actually making things happen. Because of the powerful assist this equipment can give, it can enable managers to dramatically extend their span of control with obvious dividends in higher productivity and sounder decision-making. The equipment can act as a manager's alter ego and goof-proof administrative assistant in day-to-day management and in attacking the strategic questions facing his firm.

Tied to the information system computer, this equipment can actually initiate specific activities based on preprogrammed time and event triggers. In matrix management, one of the major difficulties is scheduling the normally intense rounds of interdisciplinary meetings that are key to rapid progress. With all involved managers and professionals filing detailed personal calendars, such meetings can be scheduled with relative ease without the usual multiple round of calls needed to find a mutually agreeable time. The computer can even help reshuffle meetings when necessary and send out automatic reminders to all participants right up to the moment of the meeting. Similarly, the computer can send out routine reminders on deadline material until it is sent. Since the prods are computer-driven at regular intervals, the system itself absorbs some of the hostility normally directed at managers who earlier did the reminding in person or by memo.

The system also can permit the screening of incoming materials originated either inside or outside the company. Titles and abstracts of important articles, papers and reports routinely are entered for a quick scan by all those interested. Access can be limited on sensitive material. With an activity management function, automated offices can play a decisive role in increasing productivity.

When reviewing office automation products, there are devices that fit into several categories, but there are stronger linkages between some than others.

Clearly, information retrieval and transfer are closely linked, as is personal processing and activity management. Typical applications include document image mail, information tracking and audio conferencing.

Equipment used to perform these functions currently varies and will continue to do so, but can be best judged effectively by users when broken down into the five physical components that most systems use and then individually compared.

● *Input.* This converts information from human-recognizable form to machine-recognizable and storage form. For example, the keyboard on a word processor is the input component through which an operator translates a handwritten draft into impulses on a magnetic media.

● *Output.* The component that performs the reconversion, translating from machine-recognizable/storageable form to human-recognizable form, *i.e.*, inkjet printers that translate mag cards into typewriter quality, human-readable documents.

● *Storage.* The electrical, magnetic and optical filing of information that can be done on microfilm or microfishe, nine-track computer tape, computer disc, diskette, cassettes, magnetic card or other media, both on line or off.

● *Transport.* Transfers information either electromagnetically or optically between devices.

● *Processing.* The capability to perform logical arithmetic or formatting manipulation of information, as well as the control of all four previous physical components.

By determining the applications performed by a particular office, you can select the category of functions that need to be fulfilled and judge available equipment by the quality and features of the five physical components that fulfill these functions.

Next Steps

A detailed and practical schedule is needed to make sure that advanced office systems planning best matches available technological solutions to business needs. The process must involve defining current support requirements and potential benefits of automation, designing the appropriate systems, and estimating the resource requirements necessary to achieve those plans.

Many companies have already begun this long and painstaking process. Exxon, Mobil, Avon, INA, Nabisco, CBS, McGraw-Hill and dozens of others are currently examining their opportunities for better utilizing office automation products, and some firms have even created a new position: a director of office automation. Although the titles occasionally vary, and the responsibilities range from simple advisory to wholesale implementation and management duties, the position is, in almost all cases, that of a company-wide coordinator insuring an integrated approach to automation.

The existence of these lynchpin jobs indicate that top management's commitment to change has begun and implementation is underway. Although there is no perfectly completed, totally automated office yet established, pilots and partial conversions are springing up all over the country. Many have been instigated in combination with a relocation, since a move presents a perfect opportunity to reevaluate and make changes.

The second vice president and manager of support services at an East Coast bank explains, "We're about a year into implementing a support system. We've investigated principals' needs in terms of support and [secretaries' and clericals'] ability to supply it . . . We're seeing change right now with our implementation of an automated support system. My mind was absolutely boggled by the new technology. In telephone systems, it has the capability to do anything except pick up and go to lunch."

An internal consultant working on a conversion states: "We have a couple of parallel activities. We're implementing, where cost-justifiable, individual applications of technology, like word-processing, with some concern for long-range compatibility. We also have in our Administrative Services Division an office automation coordinating committee. We're going to be doing some prototyping of more comprehensive office automation systems."

John Blood of SmithKline cautions, "You can't jump into this thing on a piecemeal basis. It must be a planned program with sequential steps to insure that you'll reap all the benefits."

Planning and bringing to successful completion a conversion to office automation, therefore, must successfully address all the key issues already described. The eight-step approach suggested below can go far towards insuring success, but your solution, of course, must vary depending upon the unique needs of your situation. The outline below helps make sure that all aspects of office automation strategic planning are covered, but, realistically, the skill of a Houdini still may be needed to pull it off.

Step 1. *Create a detailed work plan for the project.* Because of the implications and tremendous breadth of an undertaking like this, a fully detailed, time-phased plan is necessary to describe tasks that must be undertaken, manpower necessary, elapsed time for each task and target due dates. Such a plan will help control an unwieldy, major undertaking. Most importantly, the plan should be approved by top management before the program begins, which guarantees its knowledge of and involvement in various steps. The plan should also detail the involvement of other corporate groups where it is necessary, such as Personnel, MIS, or Administration.

Step 2. *Learn your company's business needs and relate them to office automation implications and opportunities.* Too frequently, sophisticated technicians are assigned to projects of this nature, who have little or no understanding of the business of business. Those involved in designing automated systems must understand the future business directions and strategies of the corporation and compare the operating objectives, long-term positioning and economic and regulatory constraints to available technological solutions. For instance, rapid growth, industry needs, competitors' capabilities and even the overall economy are important considerations when designing a system. Governmental policies, new business strategies, cash flow or changing marketplace conditions all should impact the plan.

Because of the certainty that meaningful office automation will vastly affect both day-to-day operations and strategic outlook for the enterprise, rigid analysis of where the company is and where it intends to go are essential. When the planning process is ended, if it is successful, the firm will commit itself to a phased implementation program that will merge downstream with the company's evolving business and market strategies.

At this early stage, planners must be careful to remain flexible both in terms of technologies, need assessment and the provision for human factors. The end result of this planning process is little different from any other. Success will not be determined by the depth or brilliance of the plan alone, but by whether it is workable.

Step 3. *Select applications systems concepts best suited to your firm's business needs.* By applying the set of available automated office concepts to the business needs of the company, a backbone application as well as additional possible attractive piggyback opportunities should shake out, be they in personal processing, information transfer or retrieval, activity management and/or conferencing. At this point, organizational alternatives must be considered. Should devices be located in centers, in clusters, or individually? Should they be used by dedicated full-time operators, or by multi-function personnel? Should devices be located at the professional work station or by secretaries, or perhaps only one should be assigned within a department?

Distributed information systems, those that even permit terminals and other equipment to be located at great distances from the main computer, offer enormous flexibility in planning new offices. For instance, sales forces can be deployed where their sales potential is highest, once the need for physical availability to main offices is removed. Some sales personnel already travel with small, portable terminals the size of briefcases. Using the hotel or any handy telephone, the salesperson can open a direct link to the central computer, keying in requests for availability dates, prices and the required variables in the production run. Once a sale is concluded, the portable terminal can pass the needed information directly.

As noted earlier, it is expected that many customers will choose increasingly to place orders directly from their terminals to the suppliers' computers. During rapidly changing business conditions when inventory control is especially crucial, this sort of option can have enormous economic impact. As architecture falls into place, planners need to establish a system of priorities that combines the predetermined criteria for potential solutions and the interrelated business strategies they must address. Also, planners must begin working toward specific rather than general goals. Therefore, it is important that past work and estimates of future needs be checked for accuracy.

Armed with what amounts to a first-cut solution, the planners must then determine resource requirements to bring about such a solution. Financial and personnel needs must be weighed carefully and then factored in with a prudent estimate of what future technical, human and financial resources the company can commit to office automation. Solutions arrived at without a hard-nosed assessment of real-world constraints can virtually preordain failure.

Step 4. *Conceptualize the architecture of the system.* The user must develop a conceptual design of the proposed system based on available technology, price/performance and vendor service and support records. Systems Architecture must be described in terms of the five physical elements previously mentioned: Input, Output, Storage, Transport, Conferencing. At this point, organizational alternatives must be considered. Should devices be located in centers, in clusters or individually? Should they be used by dedicated full-time operators, or by multifunction personnel? Should devices be located at a professional workstation or by secretaries, or perhaps only one assigned a department.

Step 5. *Define and address human resource issues.* The reaction of the end user to automated office support systems must be considered, including behaviorism, impact on MBO's, staff orientation and preparation and habit changes. The people problems are perhaps the most difficult issues to resolve and will be discussed later.

In addition, human resources to undertake the conversion physically must be located, and allocated to the tasks ahead. In this area, senior management must take a strong hand during the planning process. Subordinates and those with experience in early, less sophisticated office equipment may press for less than optimum solutions as they seek to defend or enlarge their own turfs in horse trading that may facilitate action, but can prove fatal in such a venture.

Senior management must consider whether those already on board with expertise in the fields of data- and word-processing, telecommunications and the like have the abilities to move into crucial management roles in the new office structure. Remember, the new technologies involve massive and potentially dangerous change. Top management should view the decisions made on the issues of supervision, reporting and authority levels to be as important as they would be when establishing a new division upon which the firm places major hopes for future profitability.

Step 6. *Select appropriate hardware.* Basic assumptions must now be made about the equipment itself. Key considerations are availability, price flexibility and the performance of hardware, software, telecommunications and related items. Architectural requirements then will begin to suggest themselves as the list of expected information flows is juxtaposed against technology assumptions. Negotiations with vendors must begin, equipment must be selected and displayed; and operating staff must be trained.

Step 7. *Design the management process cycle.* With a workable program for implementing office automation, planners still have not completed work on critical issues. An especially crucial consideration involves the management processes necessary if the new systems are to work at optimum levels. A most common cause for failure in achieving hoped-for productivity gains from automated office equipment is not establishing new management systems that will provide smooth and efficient operations.

In this often overlooked step, a number of critical new management processes must be developed to translate the plan into a successful set of operations. Cost audits and post-installation reviews need to be devised to enable the user to establish and maintain the cost-effective, efficient service-oriented automated office environment. A permanent staff of service-oriented, technically knowledgeable, bottom-line personnel must be recruited or developed to manage the new systems.

Consideration must also be given the development of specific productivity increases among the entire white-collar work force, from the executive suite to file clerks. Again, top management must be deeply involved in this element of the planning process because without leadership from the top in this area, the pace of improvement and the ultimate level of productivity gains may prove disappointing.

Step 8. *Address organizational issues.* Finally, you must identify and resolve organizational issues such as end-user involvement, information policies, standardization and operational responsibilities to insure acceptance and proper coordination and control of office automation strategies and implementation.

* * *

In summary, senior management must be aware that office automation is not simply the acquisition of new and better technology. In 1977, for instance, the Government Accounting Office reported that the federal government spent $80 million on automated typewriters and word processors (expected to reach $300 million by fiscal 1982). Yet the GAO reports: "Most agencies cannot demonstrate that their word-processing systems have increased productivity." Equipment alone is not the answer, and top management must stop the unplanned proliferation of machines to insure a cost-justified, totally integrated, strategic approach to the office of the future. A comprehensive program must be devised that will provide such key benefits as:

- Standardized feasibility studies to insure company-wide conformity and a basic cost justification.
- Compatible equipment selection to allow for future systems integration.
- Usage as well as equipment cost controls.
- Expense allocation.
- Bulk discount purchasing where feasible.
- Education and training programs for clerical, secretarial and professional staff.
- Internal expertise in office technology to design and maximize systems and benefits.

A program such as this cannot be successful without senior management guidance and support. Office automation offers an important strategic opportunity for business in the 1980s, but, as with any new opportunity, only the best will manage to reap those benefits fully. Just as the Seventies saw the birth and early development of the office automation industry, the Eighties will be the decade when the tools will be mastered and accepted as commonplace. The firms that effectively manage this transformation will wind up winners in the drive for increased profitability and productivity. The loser may not even survive.

The People Problem

Without question, the major impact of automation will be on people. Unless office workers are convinced of the benefits, even the best products, most cost-effective systems, the most sophisticated marketing campaigns and an overwhelmingly apparent need for automating information management, will fail to obtain a

change away from traditional manual systems to automated ones.

Office automation needs to be sold just like toothpaste or perfume. A new system will have to be sexy, attractive, with obvious benefits, and even with clearly defined disadvantages for *not* accepting it.

Before selling begins, the first step must be self-education and heightened awareness on the part of top managers to close the educational gap between themselves and the evolving technology. While special committees and technicians will help, in the end it is senior management that must commit to new technologies. The key issues are "which" and "how fast." Only then will middle management and other employees learn the new technologies. Vendors' knowledge is generally too exhaustive and is commonly dispensed in jargon. Therefore, top management should insist on laymen's explanations when equipment and capabilities are discussed. Since most top executives left school before office automation began, many suffer from a technology comprehension gap that they fear exposing.

Executives currently in the prime of their business life have been away from school, on average, for fifteen years—a critical span during which most of the data-processing and office systems revolution has evolved.

People have a relatively common reaction to change: they resist it. To determine why the resistance exists and how best to handle it, one must understand the office place as a microcosm of society.

The office has a strong status structure with clearly drawn lines of demarcation between various working groups and stereotyped models for particular job titles. For instance, although female executives have become widely accepted, male secretaries still elicit smirks (currently 99% of secretarial positions in the U.S. are filled by women).

Until recently, women in the office were supposed to fill a supportive role, perfectly mirrored by the secretarial position.

But significant changes are taking place. "Young women now want to be presidents, not secretaries," says Samuel Gabe, director of word processing and a career counselor at Coog People Personnel Specialists.

Apparently, feminism and the economic imperatives that necessitate a job rather than making it optional, have helped foster this sociological change. "I'm going to do it for the next fifteen years, so I'd just as soon make an executive's salary as a secretarial one," comments Ellen Cohen, a senior secretary in a large New York advertising agency.

What has this to do with office automation? It's because traditional secretarial roles are looking increasingly less attractive to the group that traditionally filled them. A serious shortage already has developed, states Charles Rosenthal of Snelling & Snelling, personnel specialists. He says, "There is still a tremendous need for these people, but with so many women getting four-year degrees and finding executive positions, there is no one to fill the jobs."

Those who remain in the ranks not only will have more leverage, but are likely to be traditionalists who resist change and any conflict with their self-image of a white-gloved gal Friday rather than a machine operator or computer programmer. This is why the secretary must be the first target.

There is also a resistance to the production orientation of automation. Says one Detroit secretary, "If I wanted to work on an assembly line, I'd be making more money at the GM plant. Nobody in this office is going to measure how much I type or file a day." Her reaction is typical of many office workers who chose their workplace over more lucrative, but lower status blue-collar jobs.

Additionally, many secretaries fear that automation will rob them of their job skills.

Despite such apprehensions, change will come, mandated by the information explosion, operating cost pressures and management style changes. And these alterations will bring to secretaries such benefits as:

- *The reduction or elimination of boring or repetitive tasks.* Retyping and frustrating corrections and editing will be made much easier by word processors.
- *Automation of mindless office jobs.* Copier machines that automatically collate and staple, for example, eliminate a thankless task.
- *Increased career opportunities.* As human resources become more appreciated, better career options will be developed for all talented staff members, including secretaries, integrating them into mainstream corporate tasks.
- *Increased payscales.* For good secretaries, the ante is rising, with a $15,000 annual salary not unusual in many cities and no limit in sight for good ones.
- *An opportunity to develop new skills.* A quick look at any newspaper shows listings for word-processing operators—a new job category that didn't exist five years ago. Many jobs will evolve from office automation.

The benefits of automation must also be sold to professionals. Resistance to change from professional staff members, if anything, is stronger and certainly more vocal than among secretaries.

Because their power base is greater than that of secretaries, professionals' objections to change are even more important to overcome. Again, there is a status issue involved. All junior executives look forward to being served by assistants of their own. Using an electronic mail system or automated tickler file does not carry the cachet of a private secretary.

Executive technology, therefore, must be imbued with a high status connotation. It must be perceived as a "perk," not an imposition. Attractive packaging, dramatic benefits and good human engineering, insuring ease of use, will go far to overcome such objections.

Fear is frequently another issue, but even more difficult to address openly than status. Older executives frequently feel threatened by new ways of doing things, and even are concerned that they will make mistakes and be ridiculed.

A corporate administrative manager at a Midwestern petrochemical company explains, "We actually have private tutorials for the senior executives to teach them our systems so they won't feel uncomfortable learning in front of their subordinates."

But the status issue will be more difficult to resolve, and it will be far easier to fit the automated system to the present sociology than change the way people view totems and symbols. "Selling" the changes and retraining valuable staff can make the telling difference between success and failure in automation.

A major Chicago bank even created a twelve-person internal marketing group to sell the benefits of its new instantaneous retrieval information system to other employees.

To some extent, this needed sell has been undertaken through advertising and seminars by the equipment vendors, who obviously have a vested interest in seeing their products accepted. But the audience addressed—top management and the purchasers of office equipment—are not the end-users. End-users (secretaries, file clerks, professionals and managers) need to be sold by more direct means.

Increased company profits, for instance, will not motivate the average secretary to use a word processor unless there is a clear benefit to her individually as well.

"There are criteria that the vendors will have to meet," says Gerald Tellefsen, a Booze, Allen vice president. "An office machine designed for executive use will have to be simple to use, stand alone to insure reliability, educate the operator as to its use and look attractive."

There still will have to be retraining of executives. Management will have to spend money to make money, and retraining must address not only finger skills, but mind sets. "Executives will have to change the way they work to be effective in the office of the future," states consultant Howard Anderson. He continues, "We estimate that 80% of current U.S. office workers will have to undergo some retraining in the next decade."

Although the investment in capital, man-hours, and the risks of change-induced trauma are staggering, the reeducation of America's office workers at every level will be crucial to business survival in the next decade.

While only the foolhardy would ignore the potential difficulties of mating humans to the new machines, it also would be easy to overemphasize the problem. After all, only a couple of decades ago, the computer was thought by many to be indigestible for most U.S. businessmen.

About the Writer: Randy J. Goldfield, a principal in the Administrative Management Services group of Booz, Allen & Hamilton, is a nationally known expert in office automation.

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Six Pathways To Office Automation

While you can 'get there' through WP, DP, electronic filing, or electronic mail, the trade-offs will differ in each case

BY THOMAS M. LODAHL and N. DEAN MEYER

OFFICE AUTOMATION still means word processing to many people, perhaps because historically WP was the first computer-based tool in widespread use in the general office. But over the last decade, developments in other areas have made it possible to enhance office productivity in a variety of ways. Starting with any of these pathways, one can expand outward, integrating other tools in turn as business needs warrant. Each starting point has its own unique advantages and disadvantages in building toward the integrated, automated office. This article describes these various approaches and the relative merits of each. While not a complete guide to any one, it suggests options that may help the office automation practitioner recognize opportunities for pilots.*

There are six major office automation pathways, each a valid starting point in a strategy for organizational systems change. Defined by the function they support, the six pathways are:

- Administrative text handling.
- Administrative filing and retrieval systems.
- Professional telecommunications (including electronic mail).
- Professional information gathering.
- Professional writing.
- Decision support systems.

Computer-based systems now exist which combine all of these functions (although no one system does all functions well). These integrated office systems are what many mean by the "Office of the Future." Although integrated systems are commercially available, there has been little progress in applying them in corporate and government settings. While we encourage piloting advanced systems within an office automation implementation team, they represent too big a change for most user groups directly. An office automation strategy sensitive to the difficulties of organizational change must begin with simple need-based applications.

ADMINISTRATIVE TYPING

Many organizations have experimented with various forms of WP and administrative support (AS) during the late 1960s and 70s. The typical AS system involved centralized dictation (accessed by telephone), a wholly or partially centralized WP facility, and a set of more or less ironclad procedures for the logging, production, and delivery of work. The system was sold with the objective of saving money on administrative costs, specifically in the capture of keystrokes and the production of text.

This "factory" approach focused on cost-displacement through improving the efficiency of secretarial and clerical personnel. To warrant the then-large capital investment for support personnel, implementors felt they had to gain maximum utilization of the equipment. In many cases this led to massive organizational disruptions in the name of technical efficiency, leading to user resistance. Managers resisted losing their secretaries with

*The authors discussed pilot projects as a way of getting started in office automation, in an article in last month's issue—*Editor.*

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whom they had developed effective working relationships. Secretaries resisted routinized jobs reporting to former peers, in dead-end career paths. From the perspective of many users, dubious or negative benefits were achieved after the costs of vast organizational change.

Experiments in the redesign of AS systems plus dramatic reductions in the cost of WP equipment today allow a more decentralized approach, maximizing the effectiveness of the organization rather than of the equipment. By placing small WP centers close to the authors, and giving the authors portable dictation equipment, we can encourage a working relationship between authors and the WP staff.

Managers have found that, at least in the first year, they must be prepared to add to the total secretarial and clerical staff. Instead of trying to simply save money on support people (a small percentage of the total wage bill), they are shifting their focus to facilitate managerial and professional work. Good AS reduces managerial time spent on text generation, proofing, and editing. Writing quality may be improved as more drafts are permitted. And responsive support systems have doubled the text output per professional. Our studies have demonstrated that, in these managerially focused applications, the extra new work done by the authors tends to be more self-initiated and proactive rather than reactive—just the sort of work one would like to encourage in management. These "value-added" benefits, produced in conjunction with typical cost displacement, are often the more significant portion of the benefits delivered. Even with conservative assumptions about the value of managerial time saved, we find potential benefits ranging from $8,500 to as high as $13,000 per professional served!

Experience has shown that the AS pathway to office automation can deliver significant benefits, but it requires a relatively long design and implementation time period, with a great deal of user involvement. The more reorganization involved, the higher the costs and the lower the chances of gaining user acceptance.

While the potentials of WP and AS are great, senior management is rarely interested in typing efficiency. Thus, we believe that users see this pathway as offering little visible carrot but lots of stick. It *is* appropriate where a user organization feels its effectiveness can be improved through better administrative support. Of the pathways covered here, the benefits of WP/AS, when *successfully* implemented, are among the highest.

ADMINISTRATIVE FILING

Filing cabinets take up floor space that today costs from $8 to $25 per square foot per month. Furthermore, paper files are difficult to access, and often grow without any consideration of the value of stored information. Realizing this, many organizations are investigating records management procedures. Converting paper files to microforms is a long-available but under-utilized approach; it is gaining in popularity with the dropping costs of computer-indexed microfiche and microfilm terminals. Word processing offers another storage medium as it gradually builds a library of documents in digital form.

Current estimates of the physical compression factor for digital media are about 300:1, and for microforms may be as high as 1,500:1. Floor space savings can cut filing costs by 80 percent, alone warranting significant investments. Furthermore, there is value in making the files more accessible. Mountain Bell found it economical to give each of its service representatives 18 to 20 times the number of accessible records by converting paper to microfiche, while saving about $1,500 in production costs for each 10,000 pages converted.

But regardless of medium, records management also involves a great deal of analysis of the content of files. Unless the files are reconceptualized as they are being compressed, one only makes a big mess into a compact mess. Records managers must identify the nature of files, where copies are held, how they will be used, and their expected lifetimes. This requires a great deal of time-consuming involvement on the part of users. Thus, while payoffs may be large, implementation costs are significant as well.

TELECOMMUNICATIONS

The widely used term "electronic mail" may include a variety of transmission tools such as Telex/TWX and private teletype networks, communicating word processors, and facsimile or "intelligent" copiers. However, these tools are generally administrative in nature, and oriented toward sending information to a physical piece of equipment rather than to a person.

Of more interest today are computer-based message systems (CBMS). A CBMS allows the user to enter a message (via any computer terminal), and address the message to one or more individuals or groups. The message is instantly delivered to the recipient's file space; when the recipient next checks into the computer, he or she is notified of new mail and may read it at a convenient time. CBMS permit communications independent of time, location, and schedule of the recipient. They are designed for direct use by professionals and managers (although some may wish to use the system via their secretaries). They are easy to learn and use, readily available, and relatively inexpensive.

The strong interest in CBMS stems from their potential benefits. Managers, for whom "telephone tag" has become a way of life, are aware of the need for effective communication with colleagues who may be geographically separated. Busy managers are swamped with "While You Were Out" slips, as up to 80 percent of phone calls don't reach the intended parties. CBMS are particularly relevant to project teams, and to those who regularly collaborate across multiple time zones. While CBMS tend to replace telephone calls, they do not significantly reduce travel or written

communications. Users speak of an added dimension to their communications, and closer collaboration than could otherwise be created.

The value-added benefits of managerial time savings, better contact with colleagues, and closer project collaboration are of significant interest to general management. One factor is critical to successful implementation: users participating in an initial pilot must have a strong need for regular communications, and must recognize the inadequacies of conventional media. Once a CBMS is installed, it tends to spread quickly. The approach does not require reorganization and is very inexpensive to initiate. Professional telecommunications is an attractive pathway in general managerial and project team environments. With a library of professional and managerial dialogue being built on-line, it provides a strong foundation for subsequent expansion into other pilot areas.

INFORMATION GATHERING

There are vast data bases of information highly relevant to managers that are not well utilized. The transaction data bases inside a company (an MIS function) are of significant interest, yet periodic computer-generated reports are often ignored. Furthermore, large data bases under interactive query systems offer a wealth of outside information on a timesharing basis. There can be a great deal of systems leverage along the pathway of providing better access to available information.

Delivery of internal information is often limited to periodic and custom batch reports. At a large bank in Chicago, the IBM STAIRS system was modified to provide an English-like command language allowing professionals to generate their own reports without the assistance of programmers. Utilization of the data bases over the last three years has increased by a factor of more than ten. While MIS transaction-processing remains batch, a user-friendly interactive query system provides significant incremental benefits to the organization.

External data bases, available through interactive query systems, offer another high-leverage approach to office automation. The range of services is astounding, including news wires, historical data, professional and technical journal abstracts, econometric and market data, patent and technical libraries, specialized professional data bases such as legal and medical, and even entertainment guides to restaurants and wine. A large steel firm found the use of external data bases helping to lower the price of an acquisition by millions of dollars, and significantly affecting the outcome of a multimillion dollar lawsuit (for expenditures in each case less than $1,000).

In areas where better information can impact decision-making, managers will find the information-delivery pathway a very high leverage approach to office automation, particularly relevant at executive levels. However, proper use of the data bases requires training in search strategies; this may imply either direct user training or a role for an intermediary.

In all, improving professional access to information offers a sound approach to office automation in many managerial settings. In conjunction with MIS, the administrative manager might consider new ways of integrating internal-transaction data bases with the office information environment. External data base services, with their high-potential payoffs, may be used to gain top management attention and build credibility, although close integration with other tools and pathways may be difficult.

PROFESSIONAL WRITING

Text-handling tools intended for direct use by managers and professionals offer a "desktop" or "management workstation" approach to office automation. They may be envisioned as an extension of WP, often with additional functions such as structured files, calendar and reminder features, scanning and formatting capabilities, and user programmability. They are typically closely integrated with computer-based message systems. A prime consideration is ease of use, although professional text-handling tools are bound to be more complex than a computer-based message system.

This approach is likely to provide the broadest foundation for future evolution, since general text-handling tools are the basic building blocks of most applications. But the stigma regarding managerial keyboards remains an integral part of our culture (telephone and calculator keyboards excepted). As a pathway, it can provide significant payoffs in both efficiency and the quality of writing in those areas of the organization where professionals do a great deal of authorship. It is also an appropriate pilot approach for the office automation implementation team itself, particularly where the team is authoring plans, proposals, and guidelines. Training and operational costs are moderate, the payoff is significant in the right applications, and the evolutionary potential is great.

DECISION SUPPORT SYSTEMS

Decision support systems (DSS) combine data bases, models, and statistical analyses, along with tabular and graphic formatting tools under a user-oriented interactive command language. While primarily the work of the Management Science community, DSS are clearly office information tools and are receiving increasing interest from senior management. The focus is always on the decision process (rather than the underlying administrative process), and the benefits are clearly value-added.

In areas of the organization which are analytic (*e.g.* finance, planning, marketing), the payoff from DSS pilots can be very high. The benefits are even more significant when the system begins to generate alternatives in a "what if" mode, rather than simply analyzing the consequences of an alternative. Much of the benefit of DSS comes from user's direct involvement in the design and implementation process, where his or her expecta-

tions are encoded and evolved. While user involvement is typically the major cost factor in implementation, some programming is generally required as well. Thus, DSS represents a high payoff, moderate cost approach. It is relevant where analytic skills are of importance. In the interest of eventual integration of the office information environment, we encourage office automation professionals to collaborate with Management Science groups on DSS pilots.

CONCLUSION

The six pathways into office automation described here each offer unique advantages and disadvantages to the organization. Both administrative pilots (test handling and filing) typically involve high-implementation costs, with the payoff measured primarily in cost displacement. Pathways focusing on professional support (telecommunications, information gathering, professional writing, and decision support) may offer higher leverage, but the value-added benefits (professional effectiveness) are more difficult to measure.

Many managers begin with cost-displacement applications with benefits that are easy to understand and sell. The credibility built through hard-dollar savings is then used to gain permission for value-added experiments. Ideally, each of the six pilot approaches could be initiated in different parts of an organization.

Recognizing the variety of options available today may suggest opportunities of perhaps greater importance: the office automation professional need not sell any *one* technology (solution in search of a problem), but rather can honestly offer the information tools appropriate to users' needs. By planting seeds throughout the organization, and by building credibility through solving users' problems, this manager will be in a position to drive the organization into the full office information environment of the late 1980s and beyond. □

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The Promise . . . and Pitfalls . . . of the Future Integrated Information Office

By Dr. Joseph Robertson

The integrated information environment of the 1980s is an environment that will have even more impact than the industrial revolution, an environment that will effect all aspects of our personal and business life. It is an environment that has evolved from a long technical history, for over the centuries, technology has made dramatic changes in man's life style. With these changes have come changes in society itself. Since the 1800s, we have evolved from an agrarian society to a highly industrialized nation.

Consider transportation. In just one life span we have come from the horseback society to one that can put man on the moon. Our vast networks of surface, sea and air transportation have collapsed the globe.

Consider manufacturing. We have come a long way from the hand-craftsmanship of colonial days. High-volume, low-cost automated manufacturing is our way of life.

Consider communications. Soon there will be no place in the world that cannot communicate with any other place rapidly and economically. New communication advancements continue to evolve from an ever-expanding technical base.

Consider information. It took the century from 1800 to 1900 to double the amount of man's recorded knowledge, but it doubled again by 1936, and again by 1950. It is now doubling every six years, a virtual information explosion. We see no end to this trend.

What are the impacts of these changes on our business environment? First, it is becoming more international. Not only do we have the opportunity for foreign markets, but we must face up to serious foreign competition in our domestic market. Second, our businesses face the pressures for increased efficiencies and lower costs to counteract the effects of inflation and rising energy costs. Finally, to be successful in the current business environment, we need more timely and accurate information, more timely and responsive decisions, and greater worker productivity. We are rapidly moving to the era of "telebusiness," where vastly improved worldwide computing and telecommunication networks will revolutionize our businesses.

These demands will make major changes in the way we operate our businesses. The ways of the past must give way to new means of creating and disseminating information. Technology is changing our lives. Our businesses are facing the era of the integrated information environment, an era involving the rapid growth of: distributed processing; centralized electronic files; electronic mail; facsimile networks; communicating word processors; audio/video conferencing networks; and executive information systems.

It is forecast that during the next decade a new super industry will be born, the information services industry. This industry will be an outgrowth of today's computing, communications, and office automation activities, and will have the potential for becoming a $380 billion dollar enterprise by the early 1990s. What we are seeing is a business and social revolution, a revolution that in the next five to 10 years will impact every phase of our personal and business environment. This revolution will involve information and people.

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Our society is in dynamic change. Over half our labor force is now involved in knowledge work, as opposed to manual work and this office labor force is growing dramatically. Yet, over the last 10 years, while factory productivity increased 83 percent, office productivity increased only four percent and costs have more than doubled. In 1976 we spent over $600 million operating our offices. During 1980 we will spend over $1 trillion.

All this growth has not come about by manual means alone, for we have been able to automate the process of creating an information explosion and a paper blizzard. Our society is as much driven by new technology as it is the creator of technology.

Consider some of the impressive statistics resulting from our need for more information and our ability to generate it by manual and automated means. We create 30 billion original documents every year, which is growing by 10 percent. Last year alone our copies added 100 billion pages to our overloaded filing systems. Copiers today can produce five million sheets a week and a single copier could fill 50,000 file drawers in one year. We flood the postal service with over 630 billion pages of mail every year.

We maintain four filing cabinets per employee, which will double to eight in the next five years. We will have the equivalent of 24 miles of paper for every office worker. Because of this paper explosion, we read only half of our mail, and never again use 85 percent of what we store in paper files.

Discrete Solutions

How can we characterize our contemporary offices? First, they are highly labor intensive. As more information is demanded, we tend to fight it with more office workers. Offices are highly paper oriented, with paper moving in discrete steps through a series of people-handling activities. Offices are highly fragmented. Discrete pockets of activity give little hint to the overall information system that they are intended to support. Standalone products, ranging from color-coded filing aids to giant automated files that ingest tons of paper, are offered by vendors as discrete solutions to our system problems. Yet, our offices poorly support the information needs of people, for we rarely can find what we want when we want it.

Our office sytems are generally incompatible with computer data systems. Most reports are hand typed, not computer printed, so the same work is repeated over and over again. Office costs are large and increasing, but identifying and controlling the elements of costs are difficult.

What about the labor available in our general office enviroment? Traditionally, female employees have been the foundation of our clerical work force. In the last 15 years their total numbers increased by 109 percent while male office workers grew by only 29 percent. However, increased opportunities for women in other areas are decreasing the pool of available clerical workers. As a result, we find there is more work to be done by fewer clerical workers at a rapidly increasing cost.

Many of our office problems could be overcome if we could achieve productivity gains in the office similar to those in our factories and farms. Unfortunately, this has not yet been the case. To a great extent we are to blame, for automation has consistently demonstrated its capability to improve productivity. The more the investment in equipment, the less the people costs. However, automation requires investment, and in only certain areas have we chosen to make that investment.

Today, we have invested over $25,000 in automated equipment for the average factory worker, and over $50,000 for the agricultural worker, but the typical office secretary has only $2,000 worth of equipment, most of it manual, and our managers have only their telephone. No wonder our office operating costs are increasing at an alarming rate.

Controlling Office Costs

A major issue facing management today is: "What can be done to control office costs?" Evolving technology offers the greatest promise. Computer technology has created unbelievable opportunities. A microprocessor on a single chip has the computing power of a 1955 vacuum-tube system which cost a quarter million dollars and occupied over 200 cubic feet. Today's LIS chip is approximately one million times smaller, 100,000 times more reliable, and 10,000 times less expensive than the vacuum tube computer of 1955. We find that every year the amount of logic that we can place on a single chip doubles, with no end in sight for the next decade, and the future holds the promise of continuing breakthroughs in computing and communications.

Automation in the office all started in 1867 when Christopher Sholes invented the typewriter. His cast iron device was mechanically complex, but it could generate highly legible copy at the unbelievable rate of 40 words per minute. With the invention of carbon paper a few years later, our offices became paper factories, and the office information explosion began.

Other than cosmetic treatment, there was no significant change in the typewriter until around World War II, when it was electrified. All this did was make our fingers equally powerful and provide automatic carriage return. In recent years, the concept of capturing keystrokes electronically has evolved. With electronic typing we could store and manipulate both keystrokes, and the form and format of the information. So in the 60s with the birth of word processing, we finally improved on Sholes' typewriter, and automation came into our offices.

Electronic terminals are gaining acceptance throughout our companies. Graphic terminals are used by engineers for computer-aided design, and by managers for business analysis and forecasting. Data entry and inquiry terminals feed our computers and provide timely information to decision makers. Transaction terminals keep our accounts straight and our inventories current. New video terminal systems allow us to transmit still-frame video information over ordinary telephone lines, worldwide.

Integrated Info Network

Where is this new trend taking us? It is leading us toward an integrated information network where technology will bridge the diverse information systems that now operate in our offices. It is the evolutionary outgrowth of today's computing and telecommunications industry.

We are in the computing age, and computing is growing. Computing expenditures will grow from $15 billion in 1970 to $60 billion in 1980. More people will be using computers to do more things. In 1970 25 percent of the labor force was working with them, today, about 50 percent, and by 1985, 70 percent will be using computers.

Computing is also changing. Minicomputers are probably the biggest indication of this change for while 15 years ago there were only a handful, in 1977 we shipped 88,000. By 1982 we will ship 240,000 over 25 times as many as the largest general purpose systems.

We are also seeing a dramatic cost reduction in many areas. Consider the change in costs for different aspects of computing between 1960 and 1985. With 1960 serving as the base cost, we find that today, processing capability and memory have declined to about one percent of the base cost. By 1985 they will go down another order of magnitude. While software costs are going down, the change is less dramatic because of the labor intensive nature of this area. Communication, because it is a regulated industry, shows even less cost improvement.

The major change in computing will result from distributed process-

ing. With the cost of computers going down, it will become cheaper to place a computer where the work is, rather than communicate the work to a remote computer. However, don't expect the premature demise of the large-scale computer, for as it grows larger in power, it will also decrease in cost. Distributed processing will allow data to be stored and processing to take place in the most cost effective manner, unrestricted by geographic distances and the constraints of a particular computer.

Because the computing industry is technology driven, major advancements occur from basic technology that did not even exist a few years ago. It is also user driven, however, with demands for new capabilities, applications and economies pressuring the vendors to excel in an already competitive environment.

Maybe the most significant impact of computing is the penetration into so many sectors of our economy. Computer terminals are used for data entry, point of sale, financial funds transfer, small businesses, medical offices and laboratories, and universities. Even the home hobbyist, attempting to automate his way of life, uses them.

Telephone a Major Factor

The telephone is a major factor in our businesses. Telecommuncations today is a $55-billion dollar industry supporting over 160 million instruments in North America. Expenditures will grow by six percent, but totally new devices and services will become a part of our communications environment. For example, expenditures on data communications will increase four-fold, from $5.5 billion in 1975 to $22 billion in 1985.

Today's phone systems have grown in sophistication. Automated dialers and answering systems, call diverters, conferencing, high-speed data rates, satellite and fiber-optic links, picture phones, and electronic blackboards are all part of today's communications environment.

The highly regulated communications industry is also becoming more competitive. New carriers offering new business-oriented services are starting to shake up a conservative industry. Computing and communications are moving closer together in spite of traditions, regulations, and the installed base problem. Our businesses truly depend on the telephone, and this dependence will be even greater in the office of the future.

We have seen the foundation of technology upon which the office of the future will be built. What will the office of the future be like? It will provide a wide variety of automation tools to speed up communications and make people more productive. It will involve the integration of two existing subsystems, data processing and office automation, and will create a new subsystem, information for management. All subsystems will operate over a single digital communications network.

The data processing subsystem will be a logical extension of our current technology. Large host computers will have vastly increased processing and storage capacity and will be closely coupled to other computers around the world.

Some of the newer laboratory technologies that will be incorporated in those next generation computers will include laser optic storage and printing devices, bubble memory, and ultra-large-scale integration. These will have a major impact on cost and performance. Through boardband satellite communications, dynamic computer load leveling will allow the most cost effective use of computers. Likewise, the disastrous effect of a single computer failure can be avoided.

Man/Machine Interface

Distributed processing will be the predominant means of extending low-cost computing power to where it is needed while providing the user with transparent access to other networks and host computers. A true corporate information network will evolve, providing all subscribers with large central files, appropriately distributed local data bases, and access to the full computer power of the company. The man/machine interface will improve greatly so more people can use computers in their daily activities. Friendly computer terminals will be almost as common in our offices as typewriters are today.

In the automated office subsystem, we will continue to exploit evolving technologies. Advanced versions of word processors, information management systems, reprographics, intelligent copiers, facsimile devices, and intelligent phone systems will be the standard.

Today's stand-alone devices will be replaced by multi-function products that, in turn, are elements of even large systems. For example, the office copier will also communicate and will allow the insertion of letters to be read by optical character readers and transmitted as information to a computer, or as mail to another communicating copier.

Electronic terminals will be incorporated into our secretary stations, replacing typewriters, where they will support word processing, computing, communications and general automated office functions. For example, office files will be indexed and retrieved through these terminals. Correspondence and messages will be logged, appointment calendars maintained, and projects and budgets managed through this system. Secretary terminals will also serve as electronic mail stations and will provide access to all other terminals in the company and to office information located at a central electronic file.

Electronic mail will be the primary means of moving internal correspondence. The cost could be less than postal service. Computer-based message switching will select least-cost routing, incorporate appropriate distribution lists, log transactions, provide receipt acknowledgement, and distribute invoices for services rendered. A traveler can have his mail forwarded to the nearest office terminal by his secretary. She can scan the mail at her terminal, select critical items, add a comment, and relay it to his location. His reply can be handled the same way, and if he needs more information, he can search his own office files from his temporary location.

Along with other technology support devices, portable briefcase communicators will provide the traveling executive with access to mail, office files, and even facsimile and video conferencing, all through the hotel telephone or his host's office. Electronic document generation, storage, retrieval and communication will reduce the amount of paper while enhancing the accessability of business information.

The system having the most significant impact on our businesses will be the information for management system, for people-to-people communications is the mark of our business operation. The objective of this system is to bring people, and the information they must exchange, together in the most efficient fashion. The era of "Telebusiness" is close upon us.

Face-to-face contact is the most powerful and effective method, but that frequently takes travel, and thus delays the exchange and increases the cost. The telephone is an instantaneous information exchange device. While the price is right, the exchange is less effective, and frequently we are frustrated by people unavailability. The letter is produced and sent in the millions. It has the advantages of low cost and permanency, but the idiosyncracies of the postal services and the built-in delays reduce the effectiveness of the letter.

Diverse Conferencing Techniques

In the office of the future, people-to-people communication will employ a diversity of conferencing techniques to reduce travel and improve the transfer of information. Traditional conferencing will be replaced by remote image conferencing. Facsimile, interactive graphics, and still-frame video will move discussion materials among locations rapidly and economically. Project reviews, technical exchange conferences and planning sessions can be held when needed, not when travel schedules permit. Electronic blackboards will allow many locations to share in the creative unfolding of ideas in the traditional "Chalk-talk" method. Coast-to-coast training programs will become a reality. Project engineers can make those emergency design changes when required, not when they can get together to decide what to do.

Conferencing facilities will provide the right environment and convenient access to a wide range of conferencing tools. High-quality audio is critical. Experience shows that good sound must be provided for a conference to be effective. Image communication can range from computer-generated graphics in color, to fast still-frame video, to full video, the decision being based on the type of meeting and the willingness of participants to pay for higher grades of service. Controls will be minimal and will be operated by conference participants, not technicians. Automation can be as effective in the conference room as in the factory and office.

Management Information Centers

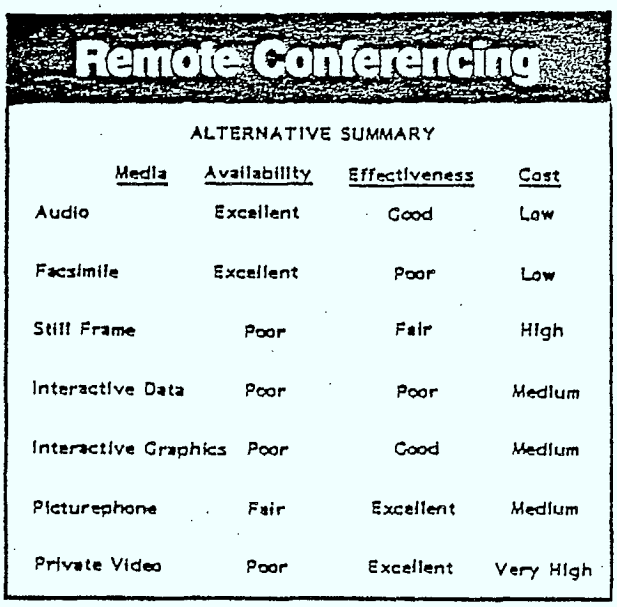
Management information centers will simplify the process of receiving key information, presenting it, interpreting it, making decisions, and communicating actions. Communications will be by high-quality audio and color video. Status displays will be maintained by computer-generated graphics so management decisions can be made with the best available information from the corporate computer data base.

When more information is required, or when decisions need to be tested, computers will aid in answering the "what if" type of questions. Easy to operate displays will cue the user through his alternatives, and selections will be made by light pen or touching the screen. Eventually, voice translation control for input and output will be available.

Examples of management information centers include still-frame video conference facilities, executive presentation centers, and full video meeting rooms.

What will be the results of this change? Information will be more available and timely, and decisions will be better and occur sooner. We will travel less but communicate more with our counterparts. We will deal less with raw computer data, and process less paper, and have infinately greater access to more useful information.

The office of the future will revolutionize our business. Through more timely information, our key executives will become more effective. Distance and span of control will become less of a management problem. While the information explosion will continue, information will be managed and controlled.



Our challenge, our opportunity as companies and as a nation, is to take advantage of these evolving electronic technologies to increase our competitiveness in the world marketplace. We must bring automation into our offices to gain technical leverage for productivity improvement. We must bring the computing concept of electronic storage, processing, and transmission of information into our businesses to stem the paper blizzard. We must recognize communications as the key to the effective dissemination of information, computer-to-computer communications and, most important, people-to-people communications.

An Office Automation Revolution

Clearly, there is a revolution in our offices today . . . it is office automation. How do we get from here to there, and what are the risks and pitfalls?

Our experience with computing and telecommunications alerts us to many problems. The proliferation of low-cost minicomputers and office systems bring needed computer power and productivity improvement to the users. However, the specter of hardware, software, data and network incompatibility, and the duplication of development effort continually threaten to undo the otherwise beneficial aspects of new technology.

The pitfalls in office automation include compatibility, control, implementation, costs, effective utilization, and resistance to change. Probably incompatibility is our biggest danger. Incompatibility can involve hardware, software, network architecture, data, storage media, standards and procedures.

From our earliest days with computers, we faced a diversity of vendors, products, systems and standards. As a result, we created an industrial Tower of Babel where few could exchange information, and the same software was uniquely developed over and over again.

The potential proliferation of hundreds of low-cost, incompatible word processors can become an extensive commitment to a dead-end strategy. The inability to communicate, the lack of compatible and exchangeable storage media, and non-standard systems and procedures can reduce the benefits and delay the evolution of an integrated information environment. The computing industry created its own chaos because the early vendors did not choose to establish conventions.

Our design of automated office systems must ensure their compatibility. Standards must be developed, if not by vendors, then by the companies that use the equipment. Communications interfaces must be specified and conformance mandated.

This leads to the second issue, the control of policies, design, implementation, operation, standards and acquisition.

An Ounce of Control Now

Our telecommunications and computing systems have grown larger, more complex, and more dependent on each other. Our office systems will follow the same evolution. Unless central planning and control is established, compatibility and logical growth will not come about. Each organization will independently take advantage of rapidly decreasing technology costs. Through lack of control, incompatibility will result. This is truly a case where an ounce of control now is far better than a pound of cure later.

Implementation is another potential problem area. Implementation involves design, acquisition, installation, training, operation, and post-installation audit.

The design of complex audio/video conferencing systems, communications networks, and large document production systems is difficult and expensive. We must avoid duplication of effort and resources whenever possible. Even the best designed systems can fail if the implementation does not take proper advantage of the technology, or if user requirements are not met.

Cost is another issue. In any advanced system, costs have a tendency to escalate. Only through the control of the design, acquisition and implementation processes can we keep our costs in line with our expectations.

Next, effective utilization of these systems must be considered. Unless requirements are fully understood, the system designed accordingly, and people trained to use the system, the advantages will not be realized. Unless users are motivated to use these systems, they will not succeed. A word processing system without contributing authors does not increase office productivity. An elaborate, but empty remote conferencing facility does not have a significant impact on travel reduction.

Finally, we must realize that office systems will be incorporated into a complex psychological and sociological environment where traditional ways of doing business will be hard to change. In addition to education on how to use these systems, we must also provide motivation on why to use these systems.

Overcoming the Pitfalls

How do we overcome these pitfalls? First, we must establish central control over policies, plans, procedures, standards and acquisition. Second, we must orient top and middle management to the opportunities and pitfalls. Third, we must create groups within each operating organization responsible for planning, designing and implementing these systems. Fourth, we must seek out the requirements, across the company, for word/text processing, electronic mail, audio/video conferencing and electronic storage. Next, we must develop plans and establish standards to ensure these systems will meet requirements, conform to technical and operational criteria, and not be subject to premature obsolesence. Finally, we must establish the most cost-effective means of implementing and operating these systems.

There are unbelievable opportunities, and the challenges are great. Our success in this next decade will depend on how quickly we recognize these opportunities and how well we meet our challenges. The office of the future is close at hand. Technology and people will make it happen.

DataComm Update!

Automated Office Adds Muscle to White Collar Productivity Drive

By Morris Edwards
CN Data Communications Consultant

The office today is an economic frontier, as the farm and factory once were. Productivity has risen just four percent over the past decade, in contrast to the 90 percent jump in industrial productivity. Many believe the problem lies in the lack of office information. James Campbell, president of Xerox Business Systems, notes that the average American farmer is supported by $54,000 worth of capital equipment and the average factory worker by $31,000 worth. For the office worker, the figure is only $2,300. Redressing this balance to achieve greater white collar productivity is what the automated office is all about.

According to one prominent management consultant, efforts at office automation have traditionally focused on the wrong objectives. Harvey Poppel, senior vice president of Booz Allen and Hamilton, of New York City says that too much emphasis has been placed on reducing office support costs and not enough on improving a productivity of managers and other professionals. Develop systems that boost professional productivity, he says, and you will automatically achieve more efficient office support as a byproduct.

Poppel believes there are four stages to improving white collar productivity, starting with office support and working through professionals and managers to the organizational structure itself. Presently, he notes, professionals other than managers receive disproportionately little support (Figure 1). If a firm concentrates on minimizing office support costs, professionals often end up doing the clerical and other support work themselves, defeating the overall objective. In one case studied, Booz Allen found that one-quarter of the professional work hours was taken up with clerical and support activity.

At the management level, Poppel sees substantial potential for productivity improvement through office automation since he estimates that at least 70 percent of a manager's time is occupied in face-to-face meetings, telephone calls, looking at reports or traveling (Figure 2). Each of these areas offers good-to-excellent potential for productivity improvement, he says, with such automated office applications as electronic correspondence, teleconferencing, information retrieval and speech mail (Figure 3).

As for organizational impact, Poppel sees new and enhanced organizational structures arising from heightened managerial productivity. In 10 or 15 years' time, he believes one of the more exciting challenges will be designing completely new organizational structures to take advantage of matrix management techniques, with flatter hierarchies and broader management spans involving fewer intermediate offices. Also, management objectives will finally be matched up with management information systems.

Digitization Sparks Automation

On the technological side, the spark plug for office automation is the semiconductor revolution which is accelerating the trend toward digitization. In particular, the digitization of text, as manifested by word processors, is laying the foundation for tomorrow's automated office, in the opinion of Daniel Lavery, director of Consulting Studies with Quantum Consultants of New York City.

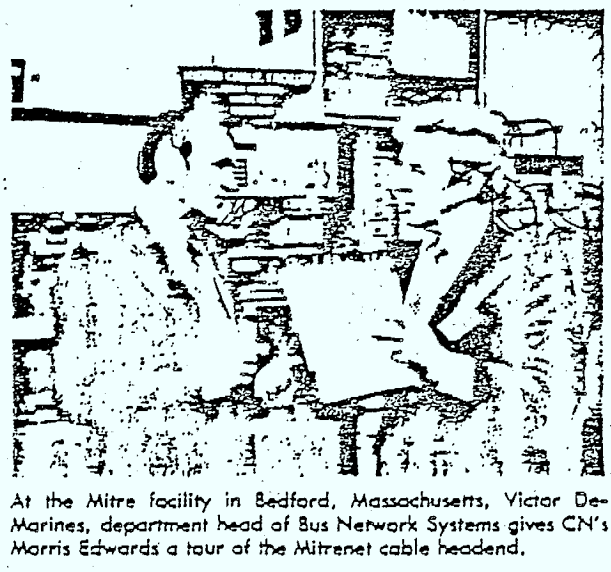
Building on this foundation will be a range of digital input, storage, processing and output devices linked by digital communications facilities, he believes. For example, Lavery envisions the digital telephone evolving to an executive work station by progressively adding special function keys, a limited display, hard-copy printer and freeze-frame display. Later will come such features as digital dictation and voice storage (Figure 4).

By digitizing dictation and storing it in random access memory, he notes, it will be possible to add, delete or change phrases in a similar manner to text editing today. A more generalized integrated work station would incorporate the telephone and dictation features and also include keyboard, larger display, printer, removable storage, processor and interface to a wideband bus and/or telephone network. Lavery also anticipates the development of three types of intelligent copiers: a convenience-oriented unit for local copy centers; a process-oriented unit for word processor and composition centers; and a production-oriented unit for electronic mail rooms and regional print centers.

Another consultant who sees the word processor as the key to the automated office is Dr. James Rudolph, vice president of Gnostic Concepts of Menlo Park, California, a consulting firm that has done several analyses of end-user requirements in voice, data, video and message systems. According to Dr. Rudolph, the word processor is finally starting to penetrate the office and he believes it is on the threshold of dramatic growth.

Despite the problems that need to be resolved with communicating word processors, these devices are "a gleam in the eye" of many businessmen, he says. In contrast, he is surprised to find that facsimile figures less prominently in office automation plans. Dr. Rudolph acknowledges that most of the excitement over these products comes from middle management, and he feels that the evolution to the automated office will be paced by how quickly these people move up the executive ladder.

Reprinted from the May 1979 issue of COMMUNICATIONS NEWS



At the Mitre facility in Bedford, Massachusetts, Victor DeMarines, department head of Bus Network Systems gives CN's Morris Edwards a tour of the Mitrenet cable headend.

Ethernet Meets On-Site Needs

Booz Allen's Poppel expects three types of integrated work stations to evolve: an event-driven station for managers and administrative secretaries, an interactively-driven one for professionals, and a procedure-driven one for clerks and other office support personnel. Typically, these and other devices will be interconnected within a facility via a communications bus or loop which, in turn, will connect with other sites, including possibly the home, via one of a variety of network alternatives (Figure 5).

Already these network alternatives are being developed by the likes of AT&T, Satellite Business Systems and Xerox, and will be available in the early 1980s (see *Communications News*, April 1979, page 38). Xerox has also pioneered the on-site or local area networking concept with its Ethernet scheme.

Developed at the Xerox Palo Alto Research Center, Ethernet is a broadcast communications system carrying digital data packets among locally distributed computing stations. In the Xerox publication, "Ethernet: Distributed Packet Switching for Local Computer Networks," Robert M. Metcalfe and David Boggs explain that Ethernet uses tapped coaxial cables to carry the variable-length packets among such devices as minicomputers, printing facilities, file storage devices and central computers, as well as long-haul communications equipment. The transmission medium, or Ether, is made passive so that failure of an active element affects communications with only one station. Suitable media include coaxial cables, twisted pairs and optical fibers.

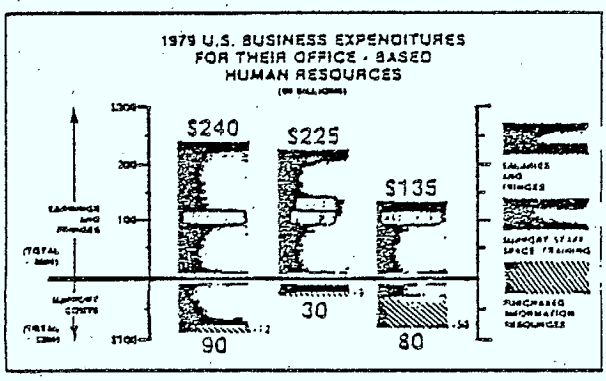


Figure 1—In today's offices, the non-managerial professional suffers most from lack of support. Source: Booz Allen and Hamilton.

Because of the layout and changing needs of office buildings, Ethernet was selected with a topology that can readily be extended or reconfigured with minimal service disruption. Metcalfe and Boggs describe its form as an "unrooted tree', since it can be extended from any one of its points in any direction. Any station wishing to join an Ethernet taps into the Ether at the nearest convenient point. There must be only one path through the Ether between any source and destination, Metcalfe and Boggs point out, since if more than one path existed, a transmission would interfere with itself.

Control is completely distributed among stations, with packet transmissions coordinated through "statistical arbitration." Transmissions initiated by a station defer to any which may already be in progress. Once started, the transmission is aborted if interference with other packets is detected and the packet is rescheduled by its source station. Ethernet controllers in colliding stations generate random retransmission intervals to avoid repeated collisions. Metcalfe and Boggs explain that the mean of a packet's retransmission intervals is adjusted as a function of collision history to keep Ether utilization near the optimum with changing network load. Even without collisions, a packet may still not reach its destination without error, so users may opt to include error control procedures in the stations.

One user of the Ethernet concept is the NBS Institute for Computer Sciences and Technology in Washington. Robert Carpenter of the Center for Computer Systems Engineering explains that the network spans about 20 buildings covering a distance of 1.5 km and provides full connectivity among terminals, microcomputers, minis, host computers and dumb laboratory instruments. Because of the diversity of devices connected to the network, Carpenter and his associates developed a microprocessor-based node called a

TIE, for Terminal Interface Equipment. Each TIE competes for the use of the cable only when it has something to send. Since transmission is by packet with end-to-end flow control, the two corresponding user stations may operate with different bit rates and, in fact, the Institute's network accommodates devices with speeds from 110 to 9600 bps.

Carpenter notes that there is a statistical probability that two or more TIEs will try to use the cable at the same time, even though each one waits until the cable is free before transmitting. As with Ethernet, the technique is to detect these collisions when they occur so that each party to the collision can immediately truncate the packet being transmitted rather than tying up the network with the complete transmission of already damaged packets. Each station then imposes a random waiting period before attempting to gain control of the cable. In this way, the network is able to handle at least 2000 user nodes.

In contrast to these baseband systems, Mitre Corporation of Bedford, Massachusetts, uses a radio frequency system on coaxial cable to permit multimode operation. According to Victor DeMarines, department head of Bus Network Systems, the modes include voice, video and digital transmissions involving telephones, TV cameras and monitors, teleprinters, CRTs, computers, printers and entry control devices.

DeMarines notes that contention techniques take advantage of the low duty cycle, or "bursty" nature of data transmitted from terminals and computers to minimize bandwidth requirements. With such techniques, the network need only provide enough bandwidth to match the average aggregate data transmission rate of the entire population of users, rather than the sum of the peak rates required in more conventional techniques. This is a key factor in the Mitre system, known as Mitrenet, since the cost of the bus interface unit (BIU) connecting subscriber devices to the cable is critical and its price increases with speed.

Mitre calls its network an unslotted carrier-sense, multiple-access bus communications system. DeMarines explains that multiple access means that all subscribers share the digital channel, have access to all information on the channel and can transmit to all subscribers. Carrier sense means that no subscriber starts a transmission if it senses the carrier of another subscriber. Further, Mitre uses the listen-while-talk contention feature, whereby all subscribers listen to their own transmission for at least the maximum propagation delay of the system and abort transmission when a message collision is detected.

In Mitrenet, the BIU connects a subscriber device to the inbound and outbound cable system. The BIU accepts data from the subscriber, buffers it until the channel is free and then transmits the data as an addressed packet. The BIU also scans each packet on the bus for its own address. Any packet intended for the subscriber is read from the channel into the buffer and the BIU then clocks the data to the subscriber device at the proper data rate.

Mitre is developing the multimode communications system for a number of Department of Defense and other governmental organizations. Its McLean, Virginia, facility will soon be installing a similar cable system which it plans to interconnect with Arpanet. (Note: Mitre and NBS are cosponsoring a symposium on the latest developments in "local area communications networks," to be held in Boston's Copley Plaza Hotel May 7 to 9.)

Industry Titans Jockey for Position

In theory, at least, the automated office might be structured around a company's communications capabilities, its existing data processing systems, or its office information support systems. Xerox believes the latter approach is the most valid and is addressing it through the vehicle of the office workstation.

"Ultimately, data processing, communications and office information systems will be fully integrated," notes James Keil, vice-president for planning, for Xerox Business Systems. "The questions are: Where do you begin? And, what is your orientation toward the role and use of information?" Keil believes the workstation approach allows you to begin where the really important work gets done . . . at the desk. "In this respect, it differs from a data processing approach which imposes several layers of clerical and professional specialists between the data and the end user."

Keil believes that, since future systems will have to provide a high level of compatibility and flexibility, the industry will have to skip one of DP's evolutionary steps—what he terms "architectural exclusion of competitive equipment." Office information systems will have to accommodate a wide range of different functions for different information needs, he argues. "This strongly suggests a need for broad-ranging equipment compatibility . . . and begins to suggest the central role communications will play."

Another key element of future systems will be "friendliness," Keil believes. "System complexity must be transparent to the user," he explains. "Unlike a pure data processing system, the office information system will be at the heart of the decision-making and problem-solving functions of the corporation. It will have to be instantly and easily accessible to everyone in the process, from the administrative/clerical person to senior professionals and, ultimately, to managers and executives."

In its approach to the automated office, IBM appears to be covering all the bases, with its communications subsidiary, Satellite Business Systems, its Office Products Division (OPD), and its Data Processing and General Systems Divisions (DPD and GSD). Industry observers are intrigued by the apparent growth in competition between DPD and GSD, and between these two divisions and OPD. Terminal systems supplied by GSD, for example, offer word processing capabilities, and DPD recently entered the office via its 3730 distributed office communications system, a word processing terminal that is supported by a 3791 communications controller.

By linking the 3730 with the 3791 and marketing it through DPD, IBM seems to be attacking office automation through an organization's data processing department. The fact that DPD calls its latest distributed processing vehicle the 8100 *Information System* adds credence to this view. Industry observers point out that DPD has been more profitable than OPD, so IBM's corporate management may be giving it a chance to repeat its success in the office. Meanwhile, OPD unveiled a blockbuster product of its own with the 6670 Information Distributor, an intelligent copier that combines the speed and clarity of laser printing with the facility to receive and transmit documents electronically, merge text and data, and print on both sides of a page in a choice of format and type style.

Another mainframer, Burroughs Corporation has taken a different tack: developing the office products side of its house through the acquisition of industry leaders in facsimile and word processing, Graphic Sciences and Redactron. Recently, Burroughs emphasized its commitment to office information systems by establishing an Office Automation Division within its Office Products Group. W. Dal Berry, former president of Graphic Sciences, was appointed general manager of the new division, which is based in Danbury, Connecticut.

The lure of the automated office has also attracted major firms such as 3M, whose arsenal includes micrographics as well as fax and word processing systems, and Exxon, which has assembled a formidable array of firms in double-quick time under its Information Systems umbrella. Qwip Systems is already placing more fax machines than any other company, while Qyx has given new meaning to the office typewriter with "intelligent" versions that in-

TYPICAL DISTRIBUTION OF A MANAGER'S TIME

		POTENTIAL FOR PRODUCTIVITY IMPROVEMENT
• FACE-TO-FACE	35-45%	GOOD
• FACE-TO-RECORD	25-30	EXCELLENT
• IN TRANSIT	5-10	VERY GOOD
• TELEPHONE	5-15	GOOD
SUBTOTAL	70-100%	
AVAILABLE FOR ANALYSIS	30-0%	

Figure 2—Booz Allen's Harvey L. Poppel rates the potential for managerial productivity improvement as good to excellent in all four areas.

corporate diskette storage and communications features. Vydec picks up where Qyx leaves off to provide a complete text-processing system with interactive and batch communications features and access to telex, Mailgram and Infomaster Services.

Xerox and IBM Set Hot Pace

For the moment, Xerox's push into the automated office is spearheaded by its family of word processors and Telecopier facsimile line. Its 800 Electronic Typing System is available as a stand-alone or communicating unit in a variety of media configurations involving single and dual versions of magnetic card and cassette tape. The modular 850 Display Typing System features a 24-character window for applications that require moderate revisions, and a heavy-revision-oriented page display that shows 66 lines of 102 characters. Key elements of the 850 system include a microprocessor-controlled unit which employs two floppy disks, storing about 280 pages of information, auxiliary devices which provide compatibility with Xerox 800 systems and certain IBM systems, including the ink-jet printer, and modules which allow communications with computers and some competitive word processing equipment as well as Xerox systems.

Its Visual Type 3 (VT 3) is a computer-controlled system intended for use on jobs involving medium- to high-volume text editing. A single system can serve up to 10 work-stations and 10 printers and can store up to 2400 pages of text, available to any of the work stations. Among its software packages is one that permits communications between VT 3 units and some computers.

The Xerox Telecopier 200 was reportedly the first facsimile transceiver to record on plain paper by xerographic techniques. The fully automatic machine uses a low-power laser as light source, transmits or receives letter-size documents in two minutes and is compatible with the Telecopier 400 and 410 models operating at four- or six-minute speeds. The Telecopier 410 also provides automatic operation for unattended sending and receiving, whereas the portable Telecopier 400 is manually operated but can be equipped with an unattended answering accessory. It also comes in an international model with a selector switch that allows it to be used for both domestic and foreign communications with other Telecopier models.

Xerox's present, somewhat conventional products, however, give little indication of its future plans. For one thing, Xerox is rumored to be readying a sub-minute fax machine; for another, the firm is testing, under operating conditions, an advanced office information system that one observer has called "remarkable." Last May, Xerox installed its experimental system in the new Executive Office Building in Washington for evaluation by the White House, and now has similar systems being checked out at the National Bureau of Standards, in the United States Senate and House, and in various companies around the country.

Developed at the Xerox Palo Alto Research Center, the developmental system is based on a workstation called Alto. In addition to keyboard and high-resolution video display, Alto incorporates a 16-bit mini and disk, and is linked to an intelligent copier. What makes the unit so powerful is a set of advanced software tools and the tying together of units by an Ethernet-type wideband link. With this set up, users can handle word processing and electronic mail applications as well as photo composition and typesetting jobs. Also, the workstation can be used to create charts and graphs on paper using information typed on the keyboard and with the aid of a computer language known as Draw and a small handle controlling the cursor. The unit can store up to 1200 pages of information and print letters in a choice of several fonts in bold, italic and ordinary faces. In letter quality, the unit is reportedly comparable to IBM's ink-jet printer.

IBM's intelligent copier, the 6670 Information Distributor, is also a key element in its foray into the automated office. At its introduction, J. Richard Young, IBM vice president and president of the Office Products Division, stated that the product represented "a significant evolutionary step" toward the office

Two units of the Xerox 850 display typing system offer word processing users a choice of viewing screens. At left is the display typewriter with 24-character screen for text editing; the full-page display unit uses a high-resolution screen that displays 66 lines of 102 characters.

of the future. "It makes a new dimension of printing quality available to the office and enhances communications through its capability of being linked to computers and their data bases," he added.

An extension of IBM's Office System 6 family of products, the Information Distributor receives and transmits documents over switched or leased lines, providing high-speed, non-impact printing of information directly from the line or from magnetic cards, with the ability to process the text, or to merge text and data in customized print formats. It also performs condensed-format printing of oversize computer-generated printouts in a high-quality typestyle on both sides of letter-size paper without special computer programming. In addition, the unit functions as an office copier, providing up to 36 copies a minute, with the ability to interrupt a communications or text processing function and automatically resume that function when copying is completed.

With the ability to link data and text processing, the IBM 6670 can print multi-page documents that contain intermixed pages in text formats and pages of computer printouts in condensed format. Variable data, such as updates to insurance policies or mailing lists, can be entered into the DP system and merged with a standard letter stored in the IBM 6670, providing personalized, repetitive letters. Also, the unit can print the address on the reverse side of the letter for use with window envelopes.

For transmitting documents or data, the 6670 operates at speeds to 4.8 kbps, using SDLC or bisync protocol to communicate with 360/370 computers, Office System 6 products and GSD units such as System/3, System/34 and Word Processor/32. Print speeds range to 400 cps for the first set of pages and up to 1800 cps, or 36 pages a minute, on subsequent sets. For text-processing operations, the unit can read 50 magnetic cards at a time, but

the printing speed for the first set of pages is only 200 cps, again increasing to 1800 cps for subsequent sets.

For control of the printer, text processing, communications and copier functions, the IBM 6670 uses two microprocessors with 128K characters of random access memory and 12K characters of read-only storage. A non-removable diskette provides storage for system operation code, including diagnostics and up to 100 standard length letters. Specific job instructions are encoded on magnetic cards using the Operator Control Language via an IBM Mag Card Typewriter or Office System 6 Information Processor, or via communications from a computer.

Meanwhile, IBM's Data Processing Division is offering an alternative means of merging DP and WP operations with its 3730 distributed office communication system, which features a text display station for keyboard entry and retrieval and a high-quality printer. Supported by the IBM 3791 communication controller, the 3730 can tie into a host System/370 computer to handle applications such as electronic document filing, retrieval and distribution—all concurrent with data processing applications. The 3730 can also be operated as a stand-alone system, allowing a user to gain experience in office applications before attaching to a host System/370.

Exxon Joins 3M and Burroughs

Burroughs' facsimile subsidiary, Graphic Sciences, of Danbury, Connecticut, got a jump on its competitors last year by announcing a networking capability, called Dexnet, that permits communications between units operating at different speeds. This means that users can choose the fax model that best matches traffic needs at each location and link all the units into a network. Along with Dexnet, the firm announced two new facsimile series that are compatible with CCITT standards: the dex 5100 digital fax transceiver that can send or receive a page in 20 seconds; and the dex 1100 series of microcontroller-based transceivers, which can reportedly communicate with the most widely used 2-, 3-, 4- and 6-minute analog fax machines.

For instance, the microcontroller allows the dex 1100 to communicate with equipment such as dex 4100 and dex 700 systems which operate in the AM mode; with other AM machines designed to CCITT standards; with FM facsimile equipment and with the dex 5100. Among the standard features of the dex 5100 digital system are modular microprocessor architecture, automatic document feed, unattended operation and convenience copying capability. Automatic dialing from an internal electronic telephone directory, simultaneous send-and-receive capability, and compatibility with high-speed analog devices are optional features.

Burroughs' word processing subsidiary, Redactron Corporation of Yaphank, New York, offers more than 30 separate models, ranging from the communicating typewriter to the Redactor display text editor. Full compatibility permits matching of the right machine to each WP function and system expansion as the user's needs grow. For interactive applications, the communicating typewriter uses IBM 2741 protocol, with IBM 2780 protocol utilized in batch modes. In addition, it can access the TWX/Telex network and the Mailgram service. The Redactor II system comes in dual and triple diskette models and dual diskette with either magnetic card or tape cassette. It also permits user programming with an English-like language called UP/1, which secretaries can employ to create complex forms and to automate other document assembly operations.

Instead of the total-computer systems projected for the automated office, 3M believes that many companies will choose a combination of electronic systems and micrographics. "An entire page of information can be captured by a microfilm camera in a fraction of a second, or it can be created in the same amount of time by a computer-output-microfilm system," notes 3M's J. C. McConnell. "In contrast to the space required for filing paper and computer readout sheets, the micrographic system permits vast reductions of up to 95 percent in the amount of office storage space that is necessary . . . and a tremendous increase in the speed of retrieving filed information."

The microfilm reader-printers are equipped with electronic counters and search systems, he points out, permitting a computer operation to call for a specific numbered item of microfilmed data, which can then be available within seconds. Low-cost copies can also be made within seconds, and large quantities of microfilmed data can be transported in less time than it would take to transmit the same data electronically. According to 3M, its SRC 1050 step- and-repeat microfiche camera and desk-top duplifiche unit for microfilm duplicating make the transition into microfilm easy.

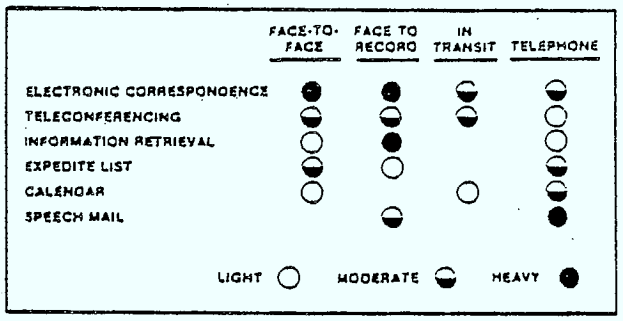


Figure 3—Level of impact of sample automated office applications on managerial productivity.

In the WP arena, 3M offers its Series 4000 system, whose software-controlled design permits upgrading without replacing costly hardware. Communications options permit interaction with host computers as well as remote WP systems. On the facsimile front, 3M is focusing on high-speed delivery. Its 9600 digital facsimile transceiver uses data compression techniques and 9.6-kbps transmission to deliver a page in 20 seconds. It also functions as a standard office copier providing six copies per minute, with the copy mode interrupted automatically to receive incoming transmissions. Standard features include full-duplex operation, automatic feeding of originals of mixed sizes and varied weights of paper, and automatic dialing for polling and transmission at pre-set times.

By the end of this year, Exxon's Qwip Systems subsidiary in New York City expects to surpass Xerox as the leader in installed facsimile units. Qwip's rapid growth from a 1974 startup was based on its Qwip 1200 model, a 16-pound transceiver designed to sit on a desk by the telephone and rent for $29/month, or about half the price of competitive units. Qwip also pioneered with its "repair-by-replacement" policy, where defective machines were replaced with another unit rather than being repaired on the spot. The Qwip 1200 sends documents such as letters in four minutes, and items requiring higher resolution in six minutes. For high-volume applications, the firm now offers a two-minute machine, the Qwip Two, which is compatible with CCITT standards for Group II machines. At the two-minute rate, the resolution is 86 x 78 lpi; for a resolution of 96 x 96 lpi, delivery takes three minutes.

Exxon's Qyx and Vydec subsidiaries presently sit at either end of the WP scale. Introduced in 1978, the Qyx intelligent typewriter comes in five models, starting with a base unit costing $1390 and offering 512 bytes of memory but no communications capability, and rising to a unit with two mini-floppies storing 30 pages each and carrying a price tag of $7,750. For Level II units and above, communications can be added for $500.

Vydec's Model 1200 and 1400 word processing systems offer a variety of communications options to permit document distribution. The Model 0700 Communicator permits text or data transmission at 100 cps between any two Vydec systems in 256-character blocks with ARQ error control. Likewise, the Model 0721 computer batch interface allows Vydec editors to transfer data to each other or to a CPU at speeds to 9600 bps. The systems can also operate through the telex network and send both Mailgram and Infomaster messages. In addition, the 2741 Plus interface option allows a Vydec word processing system to access a host computer supporting IBM 2741 protocol.

Fax and WP Forge Keys

Other suppliers are using facsimile or word processing as the entry point into the automated office, and are working to resolve the problems that plague both tools. Facsimile machines, for example, have traditionally been expensive to lease and use, and their usefulness stunted by lack of compatibility. That situation is changing with the development of faster and less-expensive units that meet internationally adopted standards. Study Group XIV of the CCITT, the international standards body for communications, has aided the situation by announcing preliminary standards for three facsimile machine types: ones that take from four to six minutes to transmit a page; ones that transmit at three minutes per page; and sub-minute machines. Besides resolving the compatibility problems, these standards also pave the way for "networking," which in turn will strongly promote electronic mail and other automated office applications. Further helping the situation is the growing availability of transmission services capable of solving equipment incompatibilities (see *Communications News*, November, 1978, page 60).

With word processors, the major roadblocks remain cost and inadequate communications capabilities. International Resource Development of New Canaan, Connecticut estimates there are about five-million typewriters installed in the US, but only about 250,000 word processors, of which no more than about 20,000 are communicating word processors (CWPs). In the November 15, 1978 issue of its newsletter, *Electronic Mail and Message Systems*, IRD identified an organizational problem that could account for the low percentage of CWPs.

"In some companies, the WP equipment is placed in centralized centers under the control of a WP manager," the newsletter states. "In other companies, WP equipment is purchased in a decentralized manner by the department head responsible for the typing that will be done on it. In still other firms, there is a mix between centralized and decentralized purchasing and installation of equipment.

"This confusing pattern of purchasing/installation works strongly against the merger of communications with word processing. In centralized environments, the pattern of information flow often leaves the WP department out of the communications picture. In decentralized environments, the units can too easily exist in a communications vacuum with not enough need to justify adding the capability, or not enough knowledge about who else in the firm has similar equipment."

However, there are encouraging signs for the growth of CWPs. Speaking at the Federal Computer Conference in Washington last fall, Alan MacDonald, communications product manager of Wang Labs reported some major changes in shipment levels of CWPs by his firm. In the past, he said, only about 10 percent of Wang's word processor shipments were equipped with communications capability, and that proportion remained fairly constant for several years. In 1978, however, the proportion of CWPs shipped by Wang exceeded 15 percent in the first quarter, 25 percent in the second quarter, and was rising past 30 percent in the third quarter of the year. Taking into account the 300 percent expansion of work processing equipment in general, this represented a nine-fold increase in CWP shipments in 1978 over 1977.

DEC and Wang Merge WP and DP

Two firms successfully pushing the integration of word and data processing are Digital Equipment Corporation and Wang Labs. According to Jack Gilmore, product line manager for DEC's Word Processing Computer Systems Group in Merrimack, New Hampshire, his firm is so committed to the future of combined word and data processing systems that "by the mid-1980s, there won't be a DEC computer coming off the assembly line that doesn't have a word processing capability."

DEC's product approach is to allow a user to start with a single stand-alone word processor and build upward into a complete information processing system. Alternatively, an existing PDP-11 user can add word processing to his present system. DEC's WP offerings range from the WS78 single-user, stand-alone system to the WS200 Series

multi-terminal system and the larger WPS-11M shared logic configurations. WS200 users can start with a one- or two-terminal system supported by floppy disk document storage and expand it incrementally to a maximum of eight operator terminals with four hard disk units and four printers. Also, WS200 systems can be linked together by communications channels, or used in a hybrid arrangement with the WS200 coupled to a host computer.

Built around a microcomputer version of the popular PDP-8, the WS200 can handle up to four communications channels. Its VT100 video terminal displays error messages, menus, prompts and texts in 24 lines of 80 characters, and allows the operator to scroll to any desired text location. For primary document and software storage, the system uses the RL01 removable cartridge disk, which can store 5M bytes, or about 2000 document pages. Two removable diskettes provide supplementary document storage of about 125 pages each. The WPS-8 word processing software for the system comes with a communications option known as WPS-8/RCP, which allows documents to be sent to a remote time-sharing system or another suitably configured WS200 at rates to 960 cps using 7-level ASCII code and error control.

For users of PDP-11/34 and larger processors, the WPS-11M software package provides shared-logic word processing capability. WPS-11M runs as a user task under the RSX-11M real-time multi-programming operating system. DEC also offers a companion document transmission software package, DX-11M which allows documents created on a word processor to be transmitted to a host PDP-11 system for storage on its desk system and/or printing on its high-speed line printer. Conversely, host files can be converted for printing on the word station's letter-quality printer and/or stored on its flexible diskette.

Wang Labs, based in Lowell, Massachusetts, provides a variety of emulation packages and communications options to facilitate the integration of its WP products into computer-based systems. For instance, the TC-B2 option adds bisync communications capabilities to a Wang Word Processor 20, 25 or 30, so that it can exchange documents with a similarly equipped unit or with a host computer, while concurrently performing local WP functions such as document creation, editing and printing. Similarly, the TC-AJ option allows the work station to function in teleprocessing systems supporting Teletype and the IBM 2741 terminal protocol. Emulation packages include IBM 3275, 2780/3780 and Hasp multileaving, together with Teletype and the IBM 2741.

Late last year, Wang extended its range of office products by becoming the first United States firm to announce the widely heralded "intelligent copier." The device combines CRT and fiber optic technology with a plain paper, dry toner copying process to produce typewriter-quality documents at a rate of 18 pages per minute, or 50 times faster than conventional electronic typewriters.

Intended as a high-speed, high-quality output device for the Office Information System 100 series and the Wang 2200 computer system, the intelligent image printer can support up to 24 WP operators. Its resolution of 90,000 dots per square inch suggests that languages previously unsuited to automatic printing can be incorporated into the unit's font libraries. Presently, six type styles are available in four operator-selectable font sizes. It employs two machine-controllable input trays so one can be filled with letterheads and the other with blank sheets. Since the printer generates the pages document-by-document, rather than page-by-page, they are delivered into the output tray already collated.

In operation, a document is originated on a WP or computer system and stored on its disk until a print request is made, at which time the document is transferred to the image printer's microprocessor control unit. This assigns the print command and selects the font and type sizes specified by the operator. A character generator then converts the digitized document into precise characters displayed a line at a time on the surface of a CRT within the printer. Each line is scanned and the image fed through optical fibers and registered as a charged image on the copier's drum. This image is then developed in the normal method with a dry toner, with excess toner removed with brushes.

The printer's price tag of $32,000 includes 30,000 printed pages free. Additional pages run 4.5 cents per copy, and there is a monthly maintenance charge of $365. Monthly rental, including maintenance, is $1375.

Terminal Vendors on Different Tacks

Computer terminal vendors are also getting their foot in the door of the automated office by featuring word processing as one element of a multifunction terminal. Four-Phase Systems of Cupertino, California, for instance, offers a WP package called ForeWord with its System IV/90, while Raytheon Data Systems of

Norwood, Massachusetts is planning to attach Videotype WP units to the PTS/1200 system as peripherals that share large common data bases in a manner similar to the IBM 3730 (*Communications News*, February, 1979, page 40). Raytheon obtains the Videotype WP units from its subsidiary, Lexitron Corporation of Chatsworth, California. Thus far, no decision has been announced on whether Raytheon, Lexitron or both firms will market the IBM 3730-type.

Lexitron's product family offers choice of full-page screen (900 Series) for volume work, or "close-up" 1/3-page screen (VT1000 Series), which reportedly facilitates composition, editing and revision. There is also a choice of storage between tape cassette and mini-floppy disk, single or double. All models can be equipped with an Interact communications feature for exchanging text among Lexitron equipment and with TWX telex machines and certain computers.

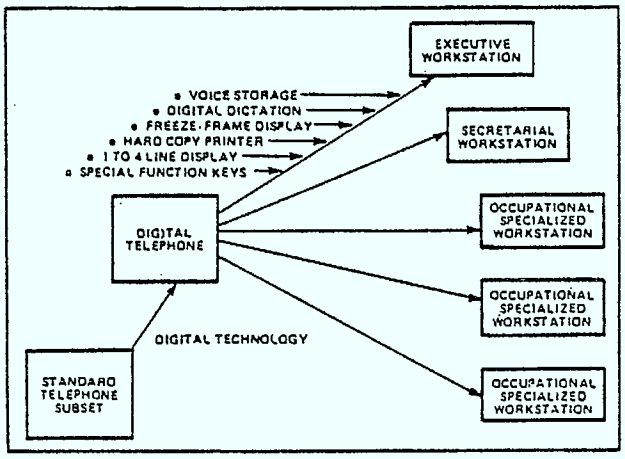


Figure 4—Evolution of a digital telephone to an executive workstation. *Source: Quantum Consultants.*

Of the firms devoted specifically to WP products, one of the fastest growing is CPT Corporation of Hopkins, Minnesota, which now claims an installed base of 15,000 units worldwide. According to CPT's Ward Johnson, an increasing number of WP users are taking the networking approach, and about 20 to 25 percent of installations now incorporate communications. Generally, the network operates under CPU control, with the WP terminal sometimes doing double duty for data entry, he says.

CPT's 8000 and 6000 systems support asynchronous Teletype emulation at speeds to 1200 bps, using the 128-character Ascii code set, as well as IBM 2780 emulation at rates to 4800 bps with the full Ebcdic character set. For communications applications, the terminals can operate in both foreground and background modes; in the latter mode, text moves from diskette to diskette without passing through the display, which thus remains free for normal WP functions. Automatic autodialing permits information exchange without operator intervention, paving the way for a computer-controlled "electronic mail" net.

For $6990, the CPT 6000 offers a half-page CRT displaying black characters on white and keyboard with 10-key numeric pad, diskette drive, and text editing software. Up to four units can share a $4000 daisy wheel character printer. The larger CPT 8000 features a full-screen display and dual diskettes.

Turnkey Sales and Leasing of New York City combines elements of stand-alone and shared-logic systems by configuring a Philips Micom 2000 stand-alone word processor with a shared data base resident in a minicomputer. The system can accommodate up to 32 on-line Micoms, CRTs, printers or communicating typewriters. Known as TIP (for Turnkey Information Processing), the system uses a mini with up to 128K core, 10M to 600M-byte disk drive and a file creation and maintenance subsystem. It communicates with the WP terminals at 300 to 1200 bps.

Last year, Datapro Research of Delran, New Jersey instituted a Word Processing Honor Roll and admitted 15 WP systems based on user ratings. Datapro's survey, conducted in cooperation with the International Word Processing Association, attracted responses from 1200

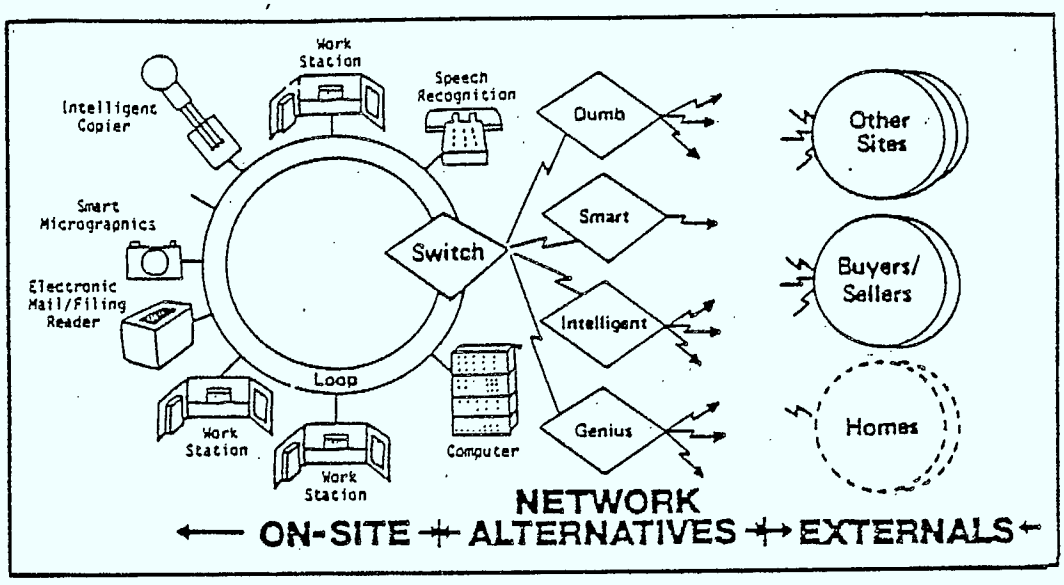


Figure 5—Within the automated office, various user devices will interconnect via a communications bus or loop. This, in turn, will link with other sites via one or more network services.

WP users, who rated more than 80 models on their ease of operation, functions/features, applications, service and support, and overall satisfaction. Datapro selected the five highest-scoring systems in each of three categories . . . stand-alone, stand-alone display and shared logic . . . to become Honor Roll members.

IBM and Xerox each had three systems in the top ratings: IBM's 6240 Mag Card, MC/ST II and OS 6/440; and Xerox's 800 ETS Dual Card, 800 ETS Dual Tape and Daconics VT 5400. Wang Labs had two systems, its Word Processor 20 and 30, named to the Honor Roll. Copies of the survey are available for $12 from the firm at 1805 Underwood Boulevard, Delran, New Jersey 08075. Datapro also offers a series of information services related to office automation, with volumes on word processing, office systems and automated office solutions.

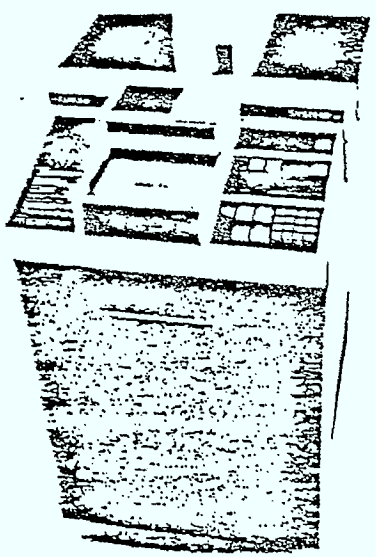
Fax Suppliers Enter Office by Mail

Of all the technologies available today, high-speed facsimile offers the greatest potential for electronic mail, in the opinion of Gary Winkler, director of market planning for Rapicom, of Fairfield, New Jersey. High-speed fax provides a hard-copy duplicate of the original document whether alphanumeric or graphic, he points out. Also, such units can handle the high throughput required for electronic mail and keep the cost per document relatively low. With the expected advances in data compression technology and the availability of wideband transmission facilities, the case for high-speed fax will be even more compelling, he believes. Increasingly, the fax units will become more automated to handle the document volume and

off-peak operation required of electronic mail systems, with features such as high-volume document feeders, improved scanners and automatic dialing and network control functions for polling automatic transmission to remote locations.

Even so, Winkler concedes that the electronic mail workhorse could be a hybrid terminal combining high-speed fax with OCR, word processing, photocopy and message-switching technology. "Such a system would combine the graphic capability of facsimile, the bandwidth efficiency and speed of OCR, the text-editing capability of word processing, and the terminal-to-terminal compatibility made possible through message-switching technology," he notes.

Rapicom's fax line includes an "intelligent" system for electronic mail, the Rapifax System 50. The microprocessor-based unit can automatically dial up to 50 telephone numbers at any time and either poll or transmit. Calling may be on a single-station or group basis with up to 20 stations, and at a frequency of once, twice or three times a day or at intervals of 30, 60 or 120 minutes. Programming is done with a touch-tone pad. During programming, a 32-character alphanumeric display shows the keypad entries, prompts the operator at the appropriate times and signals programming errors. An average page is transmitted in 35 seconds with a horizontal resolution of 200 lines per inch (1pi) and vertical resolution of 67 1pi. For a vertical resolution of 200 1pi, the transmit time is 90 seconds.



Rapicom's System 50 advances the utility of facsimile networks by allowing up to 50 machines to be polled automatically by a master station for both sending and receiving of messages.

The same transmission speeds are featured on the Rapifax 100, which is intended for users who send more than 200 copies per month. One of its accessories, a Network Broadcast Controller, permits the transmission of documents to as many as 14 receiver stations using the DDD network. For faster delivery, the Rapicom 450 operates over digital facilities at speeds to 19.2 kbps, transmitting a page in 20 seconds. In addition, the unit can operate over the DDD network at 4800 bps, matching the delivery times of the Rapifax 50 and 100. Organizations can incorporate fax into their existing message-switching networks using the Rapicom 650 Faxcontroller, which provides the Rapicom 450 terminal with access to store-and-forward message networks. The Rapicom 650 can communicate with the message switch in bisync, HDLC or SDLC protocols.

Another pioneer in high-speed fax is Panafax of Woodbury, New York, whose UF-320 was the first desk-top transceiver capable of transmitting a letter within 20 seconds. If line problems occur, the unit's modem automatically reduces the transmission speed from 9.6 to 7.2, 4.8, or 2.4 kbps. The solid-state unit is compatible with the UF-20, a console transceiver that features the same 20-second delivery speed for a resolution of 200 x 67 lpi and offers automatic answer and disconnect. For a resolution of 200 lpi, the delivery time is 37 seconds. The unit automatically selects the fastest transmission speed for best copy quality based on the density of the original.

Panafax's MV-1200 meets CCITT recommendations for 3- and 6-minute machines and is also compatible with the older electromechanical machines still in use. With the Panafax AutoDialer and Document Feeder, the MV-1200 provides store-and-forward operation.

Direct communications between fax and computer systems is possible with devices from Stewart Warner of Chicago, Illinois and Muirhead, of Mountainside, New Jersey. Stewart Warner's Datafax system comprises a digital scanner and recorder, supplemented by a microprocessor that performs data compression, character recognition and data coding functions. The computer-compatible output signal can be transmitted in digital or analog form over voice-grade or wideband link for direct entry into the host for processing, storage or for display and editing on a CRT terminal.

Muirhead permits computer-fax communications via a special interface device which thus far has been used with Honeywell, Interdata and DEC PDP-11 computers. For electronic mail applications, the firm offers an automatic switching unit that

can individually or collectively select and interconnect any fax units. Pre-programmed conference patterns may be accessed by abbreviated dialing codes. While the switch is designed for use with the firm's Mufax units, it is compatible with other popular facsimile machines. Mufax transceivers feature auto-answer capability and pushbutton selection of CCITT Group I or II mode.

Another scanning device with potential for the automated office is the Electrowriter handwriting terminal made by Infolink of Northbrook, Illinois. Electrowriter systems may comprise a single transmitter and receiver for sending hand-written messages from one location to another, or any mixture of transmitters, receivers and transceivers. A built-in function control selection device allows messages to be broadcast to any number of departments simultaneously, and operational controls provide automatic unattended message delivery.

IBM's General Systems Division (GSD) is using an Electrowriter system in its Atlanta headquarters to expedite telephone message routing. As part of its transition to centralized word processing, GSD consolidated secretarial personnel into Group Secretarial Pools serving as many as 30 managers and staff. When the pools were unable to handle the volume of calls diverted to them by the Centrex In-Dial-System, IBM created a series of message centers to which the unanswered calls could be diverted. IBM then installed Electrowriter transmitters at five of the message centers and receivers at 21 secretarial pools. Now, when an incoming call is diverted to a message center, the message is written on an Electrowriter transmitter and sent to the appropriate group secretary who delivers it to the principal as soon as possible.

Graphic Sciences' Dexnet concept allows users to operate facsimile units of different speeds in a common network.