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OFFICE COMMUNICATIONS SYSTEMS PROGRAM

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OFFICE COMMUNICATIONS SYSTEMS PROGRAM

GENERAL OFFICE AUTOMATION ABSTRACTS

Office Communications Systems Program
Department of Communications
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365 Laurier St. West
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K1A 0C8

Blueskying Without Apology About the Future Office

Here's an extraordinary and different speculation on what new technology will mean for mankind—both within the office, and outside it

BY CHARLES PHILIP LECHT

I SEE an office in a corporate headquarters complex:

O In the 1980s, a screen on one wall (screen includes all display technologies, e.g., movie screen, TV tube, liquid crystal, plasma).

In the 1990s, a screen *for* a wall.

In the 21st century, a holographic wall.

O In the 1980s, our office continues to have paper.

In the 1990s, less paper.

In the 21st century, virtually no paper. There is a desk with little but a control panel on it.

O In the 1980s, dictating equipment, a secretary, and a word processor are close by.

In the 1990s, the secretary's job will be elevated to master of the office command and control center. Voice recognition equipment will produce copy either paperbound or in electronic media.

In the 21st century, paper will be employed, but only by desire, not by need. It will be replaced by electronic media, along with voice-recognized means of storage and retrieval. The concept of data will be broadened to include everything—ideational to material. Data will occur in space as broadcast (stored) signals to be retrieved on rebound from natural and artificial extraterrestrial bodies. From massive archival media to microscopic, cell-like caches, data will be stored—and material and specifications will become interchangeable.

With the elimination of the need for paper, the oxygen component of our environment should rise dramatically (as our forests are spared being fed to the memoranda mills); staplers will disappear; our need for pens and pencils will be greatly diminished. Our arms will become freer, and discover new purposes.

The quality of meetings should be greatly improved for they will be needed less frequently. And when they *are* needed, I foresee the following developments:

O In the 1980s, teleconferencing via screen technology.

In the 1990s, the drama of two groups sitting at two tables in two locations, which are at once one table in one location brought together by electronic synthesis.

In the 21st century, two tables, each pushed against a holographic wall, bringing two groups together at one table in one room with diminished perception of dislocation.

O In the 1980s, the telephone will still be our primary means of verbal communication. This is a device plugged into a network carrying the sound from point A to point B.

In the 1990s, the need for a device physically plugged into a network will disappear, to be replaced by portable speaking and receiving systems.

In the 21st century, the need for a plugged-in device or a portable device will be replaced by the emergence of voice and image projection/reception systems invoked on-demand and appearing in our minds, ultimately via LSI (large-scale-integration) engineering techniques applied to the inmost machinery of the human cell—artificial neuronal interconnections! (More on this later.)

WHITE-COLLAR BENEFITS

The executive in the corporate office will benefit enormously from this improved technology environment: his or her integration will produce a new dimension of freedom. The strain on the biological self will be diminished and the intellectual, creative, and imaginative self can enjoy maximum *play*—both in the sense of latitude and of recreation. Time between conceptualization and realization will diminish; the notion of "altered states" will lead to a newly rehabilitated and respectable kind of alchemy, relating fact to artifact.

The other side of the coin—perhaps we should say of the chip—is the means of distributing the products of our employment.

The immediate results of white-collar work will remain bound in letters, memos, newspapers, books, reports, magazines, etc. in the 1980s, although more and more will be appearing on the screen.

As the requirement to create paper, to imprint it in some way, bind it, and distribute it increases in cost, there is an increasing trend to avoid its usage. More and more will be delivered electronically.

Between the present day and the latter '80s, a transitional phenomenon bridging the publications production stage (as currently carried out) and the pure electronic delivery stage will emerge. Not surprisingly, it will involve a mixture of electronic delivery and conventional printing.

Thus, in the 1980s there will be an increasing trend to fashion the data to be published at headquarters, then transmit it to the purchaser for printing at his or her home. The portability of paper-bound media is a major factor in its longevity.

In the 1990s, innovation in electronic tablet technology should provide us with the means to eliminate paper as a publications medium, while retaining its most valuable attribute—namely, portability. Until we can create a portable electronic tablet (within which a microprocessor will be embedded, integrating both logic and substantial memory), pure electronic delivery of reports, newspapers, books, etc. will be limited to our having to visit a terminal of some kind. It's hard to conceive of conventional publication formats as we now know them disappearing without some progress in the evolution of portability. How else could we sit under a tree in the summer breeze to read?

If broadcast technology improved to the point where we could indeed sit under a tree to read our favorite novel on a plasma screen, having invoked the "book's" contents in an on-demand mode, the issue of portability would be solved once and for all.

But information creation and distribution is a far easier task than is the distribution of other products. So, while great strides will be made in instrumenting the blue-collar/white-collar means of production, the means of delivering the material results will, perforce, lag far behind except in the pure information area. If data creation and delivery in the year 2000 is solved by electronic innovation involving both wire and wireless techniques, it's nevertheless hard to envision, for example, a panel on the wall of a consumer's residence that provides actual Campbell soup via cable, or broadcasts it directly from the factory.

Let us speak, by way of another mundane example, about shoes (consigning ships, sealing wax, and kings to some future speculative effort). In the '80s, we obtain a pair of shoes mostly by visiting a shoe store, sometimes via the mail or some other delivery service. While there is no doubt that an economically viable process of shoe creation will be incredibly aided by, if not wholly consigned to, the technology of automation, from factory to office, somehow or other we will still have to find some means of bringing the shoes and the person who would wear them together. I don't think it will ever be practical to distribute shoe factories in quite the same way as we will printing facilities, and electronically create the data to produce shoes at home.

Thus, the next big bottleneck to overcome will be that of the means for delivering hard products. A glimmer of a solution starts to appear when we consider human travel and movement in a world devoid of the need to do so except at pleasure's beck. After all, if we can work at home, create and distribute data electronically, and conduct electronic meetings in a holographic world, travel will have little function beyond amusement. Which brings us to the root (dare I say soul?) of the shoe issue; namely, there, will be a lessened demand for the shoe as we now know it. Let's face it—without having to leave your immediate environment, lots of things diminish in importance: transportation, office buildings, restaurants, even shoes.

ARTIFICIAL INTELLIGENCE

But this alone begs the question of how hard product delivery will improve. One fears that much of the increased efficiency to be gained through the electronic-office-cum-robot-factory scenario will be lost in the delivery problem. Even if teleportation were possible, its realization would lag far behind improvements in our means of production. Some breakthrough is needed to treat hard products as data. Could we be headed for a future where data and product are interchangeable on demand?

We are at once embedding LSI in ourselves at the same time as we embed ourselves in LSI. Think about it. Microprocessor chips are invading not only inorganic tools, products, devices, but also our own selves.

The first manifestation of the invasion of our bodies by LSI is to correct physical limitations. People with conditions or deformities that restrict normal performance will be the first target of LSI embedded in humans. LSI has for some time been embedded in devices that perform organic functions for human beings—for example, in heart machines.

The promise of LSI in improving crucial elements of our biology goes beyond correcting abnormal conditions. Its role in "correcting" normal conditions is the most exciting. Imagine seeing in the dark or into our micro- or macro-cosmic worlds. Could it be that all devices that extend our cognitive powers are producible as LSI? Are LSI really cells?

We are already deeply commited to the creation of massive service networks. With short and long-haul communications, wired and wireless, the globe is increasingly being immersed in a sea of communications. And anchored at various points in this sea of communications are processing nodes. This combination of communications and processing defines a massive LSI within which we are becoming increasingly embedded. If you accept the concept that the only thing differentiating an LSI embedded in us from the network within which we ourselves are embedded is *size*, some beautiful ideas result.

Yes, there are dangers implicit in this cosmos; but it's the opportunities that strike me as being of overriding interest. Communications between the microminiature LSI world and the macro LSI world, for example, can provide us with the means of internalizing holograms, endowing us with the means for effecting a form of travel without ever having to move from our seats. Captain Kirk's "Star Trek" (Star Trek II!) decomposition/recomposition machine, which suggests that we will be transformed into some kind of electronic stream, shot like puffed wheat to another location and reassembled, is far less likely than the concept I propose; to wit, that the other location can be brought to us via the massive electronic network in which we are embedded and recomposed in our minds via the LSI embedded within us.

Had it been suggested in the 1940s that large-scale-integrated networks with processing nodes could be printed through photolithographic methods on wafers so tiny that electron beam microscopes would be needed to see their elements, the most far-seeing of scientists would have called it science fiction—or something ruder. Yet, the massive networks of Univac's LARC and IBM's STRETCH have gone exactly that route. The compression ratio of these networks in converting original format to LSI analogs is astounding.

Systems the size of STRETCH and LARC once required that we literally house ourselves within them in order to operate them. The LARC had two operations consoles and a speaker-phone system between them. Other systems, like BISMAC, had thousands of tape units, for which personnel on rollerskates were needed. Is it not ming-boggling that systems of this size, logic, and memory have now been compressed onto LSI? *They* could now be housed within *us*.

I have no doubt that we will see the power vested in these systems and others like them one day on chips. How small can such systems become? Could they become the size of a cell and would it be reasonable to expect that, just as electro/chemical/mechanical technology has augmented the body in such a way as to improve its functioning, LSI will augment the cell to do likewise? The trend is surely in this direction.

Bionic devices are clearly in our electronic future. But before they appear, computing devices created first of inorganic matter and later of organic matter will have emerged. We have just begun to explore biological computing devices.

I am told that there is a cellular memory in all organic material. Of our body's sixty-thousand-billion cells, roughly one-half carry memories composed of data dating back to the primordial soup. If we could retrieve this memory, geneticists suggest that powers exercised by our progenitors could be revived. In this stream of genetic consciousness is locked the memory of how to fly and how to live under water, and perhaps even the secret of life; it ends with the death of the individual.

In order to recall data from memory, we need proper I/O channels. Communications experts speak about "handshaking," a word conveying some form of cooperative relationship between the device extracting the data and the device containing it. In my mind, I see LSI compressed to the size of a cell, see us communicating with it, and bringing the data of past epochs back. If this can be done, our technological achievement will have surpassed that realizable through natural evolution, and the narrow bandwidths of our physical and intellectual being will have been so widened that we may ultimately leave even our technology behind us. □

Charles Philip Lecht is president of Lecht Sciences Inc., a New York firm that researches areas in the forefront of science. He is also founder and past president of Advanced computer Techniques Corp., a software consulting firm. This article is taken from a presentation he made at this year's Interface '82.

Commit or Hold Off? The Short- vs. Long-Term Tug of War

Successful implementation of technology is no easy task.
Managers must have a strategy that furthers a company's overall objectives.

BY ALEXIA MARTIN

THE HISTORY of office automation reflects implementations accomplished with short-term objectives. The implementors' contention is that, if they don't implement now, they won't be able to continuously improve their business operations.

However, by taking time out now for strategy development and long-range planning, administrators can channel short-term implementations within a long-term perspective of what is good for business.

Office automation is the use of computers and communications technology to provide both information and information-handling services directly to office workers. Until recently, clerical workers have been the primary users of automation technology. The trend, however, is towards more use by professionals who require services such as word processing, interoffice communication, a spread sheet (or some other "what-if" system), and access to internal data bases. The purpose of these services is to make office workers and their administrators and organizations more effective.

USER EXPERIENCES

Let us look at some experiences with office automation to date. A 1980 review of word processing at the corporate headquarters of a large mining company showed that 15 users of word processing had acquired different equipment, even though their applications were essentially similar. Most of the users had not established either detailed requirements prior to acquisition, or recordkeeping functions to adequately measure performance after acquisitions.

Moreover, none of the word processing systems were acquired with the prospect of communicating with one another or with a view towards greater processing capability, although most users indicated the need for such capability. *(Acquiring word processing or any other advanced office automation technology to meet current, local requirements only creates a future expense, in this case, need for a word processor-to-word processor interface.)*

The manager of one of the most profitable departments in a large construction company authorized expenditures for a $150,000 word processing system to support proposal and report preparation and to communicate with the office of his superior. The word processor purchased was not on the preferred vendor list prepared by the corporate office automation group.

The manager justified the acquisition mainly on the basis of improved customer service. He explained, "Well, if I can get proposals out the door faster, I can get more business, and then I'll get a bigger bonus. Besides, the implementation will look good on my resume. *(Making the rest of the organization aware of all the benefits of the preferred vendors is an important responsibility of the corporate office automation group.)*

Critics blast the Federal government's practice of always buying from the lowest bidder. Since most computer manufacturers discount their older inventory to make way for newer models, the lowest bids often include older machines. Says one procurement officer at the General Services Administration, which buys many of the government's computers: "The low price tends to encourage buying obsolete technology." *(Buying from the lowest bidder, particularly when the technology is obsolete or inadequate, is actually quite expensive because upgrades are often needed immediately.)*

The market research department of a high-technology company recently acquired four different personal computers as a pilot test of their capabilities. Four researchers wanted the computers for various functions, mostly related to "what-if" scenarios, but they also wanted to use them to develop reports and correspondence. They justified acquisition on the basis of productivity improvements through having on-line access to information and modeling capabilities. The low cost of personal computers allows acquisition decisions to be made lower down in the organization.

As a result, personal computer use is spreading, as are personal information bases, which often duplicate corporate data bases but lack corporate data integrity. The problem here is that these personal computer users wanted to share documents. But, as with word processors, personal computers with a variety of word processing software cannot easily exchange information. It's not necessary to curtail personal computer acquisition, after all, local users are paying for them and probably have a justifiable need. *(It should be understood that to have additional capabilities—in this case, personal computer document transfer—will require additional development costs.)*

These vignettes have a common thread: they reflect implementation with a short-term perspective. Although each implementation ostensibly benefits the local user, each may also have hidden long-term costs in terms of requiring an integration effort. The expense of developing a document transfer capability with format conversions between different word processors or personal computers running a variety of word processing software is not trivial. Developing a facility that provides for interoffice communication between users of diverse processors is also expensive.

Additionally, whenever a person transfers from one department to another in a firm with multiple-brand personal computers running multiple word processing or modeling packages, the time required to learn the new computer capabilities detracts from the required activities of the office worker. All these costs, in one form or another, may result from implementations within an organization undertaken with a short-term perspective.

What's required to avoid or minimize these problems and expenses is strategy and long-range plan development, and Information Resource Management (IRM—see the box that appears on this page). Both strategy and subsequent long-term planning require a vision or target such that long-term objectives channel short-term efforts.

For example, it has been said that the Japanese have a goal of international trade success, if not domination. In order to trade, communication is required, and consequently the Japanese are learning English, the language of international trade. The short-term effort feeds the long-range objective. Any long-range office automation strategy must support and follow the long-range business strategy. If a business strategy does not exist, it must be developed so that office automation does not become an end in itself.

An office automation "vision," sometimes called a direction statement, might include the following statements:

THE VALUE IN INFORMATION RESOURCE MANAGEMENT

MUCH HAS BEEN, and will be, written about Information Resource Management (IRM). The technological underpinnings of communication, data, text, and image handling are converging, leading to opportunities for managing an organization's information, as well as its information-handling resources.

IRM implies the use of resource management tools and techniques to treat information as a company-wide resource. This perspective encourages cross-system and cross-organizational group system planning. It encourages the examination of an activity within a system as to how it flows through the system, and how it impacts other related activities.

Making the information and technology available where needed in a cost-effective way—through policymaking and coordination—is IRM's goal. Making information resources available requires knowing what information is needed.

The most important IRM tool is the data dictionary. Although originally developed to support data base management systems, when used for IRM purposes, a data dictionary is a tool for organizing, storing, and manipulating attributes of information that are shared among organizational groups and activities, and computer systems and application systems.

Through use of the data dictionary, organizations have the beginning of a common language for communicating about information resources. Through its use, individuals can ascertain whether information exists within the organization and where it is located. Using a data dictionary reduces the amount of redundant information and the costs of maintaining each.

Other critical long-term aspects of IRM are the assignment of a management-level person responsible for overseeing corporate information resources and for establishing an information-direction statement along with appropriate standards and guidelines; a consideration of information system security, auditability and maintainability; and also allowance for user-specified solutions, within a particular corporate-wide IRM framework.

The benefits of an IRM program are significant. An IRM manager and staff learn about the organization during the information requirements analysis performed before establishing a data dictionary. Their expertise allows the IRM staff to: (1) serve as a repository of knowledge on corporate information policies, thus facilitating adherance; (2) ease new systems development by providing knowledge that leads to the reutilization of existing data, avoiding duplication; (3) contribute to the business-planning process by assessing the availability of information and systems to support new operations. □

○ All office workers (professional, as well as secretarial/clerical) will have a device (terminal) through which they can access information and information-handling services necessary to effectively perform their jobs.

○ To avoid extensive integration efforts, in terms of providing protocol conversions and format translations, we will standardize on a set of terminals, word processors, personal computers with word processing software, and electronic mail packages. The size of the set depends on the requirements of the organization. For example, a company whose work is heavily engineering oriented may wish to acquire both an engineering-oriented word processor and a more general-purpose word processor for its non-engineering functions.

○ For cost and time effectiveness, some resources will be shared, such as high-speed printers, a telex connection, or high-quality graphics plotters.

○ In order to use shared resources or in case all required information or service resources are not resident in the personal terminal, a communication network will be developed that will facilitate connection of one device to other devices or processors. To use the network, those systems connecting will need to conform to certain network protocols. These network protocols will be developed from a long-range perspective.

Such direction statements as the above serve as strawmen for the management of an organization; those who may soon be users or demanders of office automation services can shape them to their consensual vision. The net direction statement will describe the conceptual target office or organization of the future. Any implementations must adhere to the statement (or cause it to be updated).

If a direction statement makes sense to the organization's management, if information resource standards and guidelines exist, and if the benefits of each are thoroughly understood, adherence should not be regarded as a hindrance, but as a furthering of business objectives.

Short-term implementations, per se, only enable an organization to combat immediate problems; implementations carried out under the umbrella of a long-term perspective will ensure continued business success.□

Alexia Martin is a management systems consultant at the Information Systems Management Center, SRI International, Menlo Park, Calif. She has developed office automation strategies and designed and implemented management support systems. She has also assisted vendors in product planning.

100 WAYS TO AUTOMATE YOUR OFFICE

A technical smorgasbord that will help managers facilitate the transition.

by David Macfarlane

Okay, you've made the decision to take the first step—or the next one—toward an integrated office system. Now what?

Well, as you've probably learned from a plethora of periodicals, seminars, conferences, and books, the implementation of office systems raises a lot of questions. Many of the questions are of an organizational or social nature and require much mulling; we'll leave those aside for the moment. There remains, however, a great deal that can be done right away.

What technical measures are possible and useful today? Because you'll want the systems you end up putting in place to fit your requirements, budget, existing systems, and attitudes, it makes sense for you to be aware of as many alternatives as possible. To that end, here are 100 suggestions on how to automate your office. They range from rather simple, entry-level ideas to advanced notions that may require some extra effort on the part of your system supplier. Think of the list as a smorgasbord. Not all of the suggestions will be immediately applicable to your organization, but all are valid, feasible right now, and food for thought.

1. Give yourself a terminal linked to one of your computing resources and use it to generate all your own documents (chances are that it will have some usable text editor and formatter). People will start to notice the higher quality and faster turnaround that you get, and it is good experience for you.

2. Give your president or ceo a terminal with some programs that can translate existing data (financial, production, staffing information) on your corporate computer into graphs, pie charts, and other forms.

3. Attach to the above terminal a printer/plotter that your executive can use for giving output to staff and associates.

4. Attach to the same terminal a 35mm slide-maker to produce graphics appropriate for presentations.

5. Get a color plotter that can make overhead foils for your presentations and graphics for your reports.

6. Give your secretary a word processor for all your memos, letters, reports, etc. (Don't forget to give her enough training to use it properly.)

7. Put a microcomputer in your department for your professional staff to use as functional support. Get spreadsheet, business graphics, and/or word processing software for it.

8. Get some language tutorial books (BASIC, Pascal, C) for your professional staff. Let them program the micro to support their job functions.

9. Get a cheap matrix printer for your micro that will support graphics and generate charts and diagrams for your reports.

10. Put word processing software onto your mainframe computer. Have your existing users employ it for documentation, report writing, etc.

11. Put electronic mail software onto your mainframe computer. Start using portable terminals in conjunction with existing users and terminals to keep in touch with staff and management.

12. Put an on-line information retrieval interface onto existing databases, and give terminals to the people who most need timely access to those data. Try to replace some regular report generation with user-generated ad hoc inquiries.

13. Get your research/reference librarian onto your messaging system. Have staff submit requests in the form of electronic messages, and answer them in the same way.

14. Using an existing computer with communications capability, write a small program that can let your librarian capture the results of the on-line queries and send them to the requestors over the messaging system.

15. Put a user-friendly interface (probably a menu, at least initially) onto your existing mainframe utilities and applications. Give terminals access to an appropriate high-performance team.

16. Give your controller or financial vice president a microcomputer with a spreadsheet utility, plus easy access to someone who knows the system. Let him or her try something small first.

17. Use a local timesharing service and a financial modeling package to develop your next departmental budget.

18. Put your time sheets onto a system. Let your secretary input them every week. Make summaries available as required in graphical form.

19. Let your professional staff input their time sheets through their own terminals. Realize greater accuracy and timeliness.

20. Put a project control system on top of your time-sheet system. Post time-sheet entries onto project budgets, track milestones reached, graph expected versus actual budgets.

21. Link your project control system to your client billing system. (Develop appropriate authorization procedures.)

22. Next time you do a questionnaire study, develop the text of the questionnaire on a system that has both statistical tools and word processing. By doing the data analysis on the same system, you will find the report easier and quicker to write.

23. Pick a geographically distributed department (e.g., employee relations for plant sites) and put it on a public (timeshared) electronic mail network.

66. Add a hard disk to the local network of micros, and encourage users to keep files on it. Cut down on floppies, and simplify software and information distribution.

67. Find a printer or typesetting bureau that can take the output from your word processors and give you back phototypeset hardcopy. With very little extra work, you can get much higher quality and effectiveness.

68. If you have a large volume of typewritten text that you wish to include in your office system, input it using optical character recognition at a service bureau. Chances are there is one that can handle your type styles.

69. If you have too many typewriters to replace and typists to retrain, start a document creation procedure that includes optical character recognition linked to word processors. The bulk input is through OCR, and authors have their marked-up drafts handled by word processing.

70. Once you have professionals doing their own document generation on a system, add some of the many programs that analyze spelling, readability, syntax, and grammar. Emphasize quality, not volume.

71. For word processing on any kind of system, keep previous versions and indicate all changes in every draft. You can use change bars in the margins or a special kind of underlining. This way the author knows what was changed and what was not.

72. Add call-out programs to your on-line system that automatically connect to the public information bureaus. Give your users access to stock information, library databases, news wire services, etc.

73. Let users specify their interests to the system so it can extract appropriate items from the news wire services and put them in the messaging system automatically.

74. Start buying desks with variable or typing-height surfaces. Many of the people in your office will be using terminals in the next few years.

75. When moving or redesigning your offices, prepare the facilities with office systems in mind. Plan ahead for extra power outlets, task lighting, air circulation, cabling, etc.

76. Do you want to hire an expert from out of town who does not want to move? Hire that person and give him a work-at-home terminal configuration.

77. Store all your on-line text documents with a content search capability. You can never predict all the ways your users will want to access material for reference or review.

78. Use your list of names, addresses, and phone numbers as a dynamic contacts database. Each time a person is contacted (by phone or letter) update the database to indicate the date and nature of the contact. Use the list so you don't get out of touch with anybody.

79. Put an on-line inquiry into your contacts database and enable access by any item (such as type of business, company name) for any item: phone number, last contacted date, etc.

80. Take the phone number fetched from the phone or contacts database and link it into the phone system—have it dialed automatically.

81. Whenever a user requests a phone number from the system for a long-distance call, give the charge rate and the local time as well.

82. Set up an abstract index of all documents in your company or departmental library. Let users browse through it at their terminals before they request material.

83. Get terminals that support magnetically coded keys or cards. Let users put their log-in sequences and passwords on the cards so they don't have to type them in every time. They'll keep the cards as safe as their credit cards, so there will be no security problems.

84. Put a computer assisted instruction package on your system, and use it as part of the training package. Learning by example is the best way. You can also track users' progress with the training, and identify problems with the system.

85. Use dictation in conjunction with professional-use word processing. You can let the authors correct and edit their own work and spare them the high-volume input.

86. Once you have several functions/applications/utilities on your on-line office system, provide interrupt and resume features. This more closely models real use patterns, and lets your users temporarily stop one activity (editing a report) to take care of an interruption (scheduling a meeting).

87. If you have both voice and text messaging, integrate them using a combination phone and terminal device (now available from several vendors). You could have one MESSAGE button that sends a voice message if the phone is being used and a text message if not.

88. Once you have messaging, use either your phone system or microphones to add voice annotation capabilities. This could work for messages and other textual documents and is already available from several vendors.

89. If you still have any regularly issued MIS-type reports coming out, use a name list on the system to selectively address the reports using the messaging system (with no ongoing operator intervention). No one gets any reports he doesn't want to see, and no one gets any paper at all (in this case, anyway).

90. Put a usage monitoring facility on any system or function that you implement. You will get valuable feedback on who is using what when, so you can upgrade, reconfigure, and retrain as needed.

91. If you have any dial-out links from your system to voice phones, put a voice synthesizer in as well. Use it to call people with reminders, to wake up the next shift, or alert operations staff to any urgent conditions ("Hi, this is your system calling...").

92. Put a link between the above voice synthesizer and the electronic messaging system. Let users call into the system from a regular phone and have their messages read to them.

93. Let the voice synthesizer help with proofreading by reading back text (and numbers). Let your readers take on more interesting and valuable jobs.

94. Make your messaging system really work for you. Using the notion of "closure," let the messaging system keep tabs on an issue by making an audit trail of messages on the topic and a list of each open issue until it is "closed." This can become a database of current activities and their individual statuses.

95. Put in a security device (keys, special passwords, coded cards) that is viewed as being as good as a physical signature. Let people use it (as authorized, of course) to give approvals. Reduce formal paperwork.

96. Let the system manage the procedures that define how a form moves through to completion and approval. Use the messaging system to automatically route and present for "signature" all the check requests, expense authorizations, etc.

97. Put analog and status sensors on-line with your system. Let the users inquire about the time in Hawaii, the temperature outside, "Is Fred in his office?"

98. Let your security staff use the sensors together with the main system. Log doors opening, lights on and off; keep records that you can summarize, graph, and compare.

99. Add to your messaging system some special capabilities to support the manager/secretary working relationship. Let a secretary prepare messages for the manager to send, let the secretary see some or all of the messages sent to the manager, etc.

100. Ensure the integration of every phase of your implementation. For example, anything (graphs, charts, data from a database, parts of a report) can be sent as a message, any data (from an appendix of a report, from a financial model) can be made into a graph. ❖

David Macfarlane is manager, integrated office systems for the Toronto office of Coopers & Lybrand. He is responsible for the data processing department and the design and implementation of advanced office systems. He was previously the senior office systems architect at Bell Northern Research, Toronto.

24. Put a programming language on your word processor, and have a summer intern build some appropriate applications.

25. Start sending documents from one office to another using the communications option of your word processors.

26. Get a black box that enables one kind of word processor to communicate with another (and then go back to the last point).

27. Send documents to your clients/ customers using communicating word processors.

28. Set up procedures to receive documents (orders, RFPs, proposals) from your clients and customers. Relieve them of printing and distribution costs, and get the text on a system that you can use for your reply.

29. Have a representative of each of your major clients on the same electronic mail system that you and your staff use. Make it part of the proposal and contract with them.

30. Put your traveling sales staff, sales manager, and secretaries on an electronic mail system. Give them portable terminals that fit in pockets. Have them use the terminals for phone messages, orders, inventory checks, and other information exchanges.

31. Give your sales staff portable printer terminals so they can print out orders, etc., in the field.

32. Take a high-powered team of creative professionals (technical writers, professionals whose main output is reports, et al) and put them on a network of advanced professional workstations.

33. Put an index to your manual filing system on a computer and let both the users and the file clerks access it. Increase availability and decrease wrong filing (especially for subject-indexed systems). This lets users access files by any criterion they choose.

34. Use a microcomputer as a remote terminal instead of a dumb one. You can use the micro for editing the information you get, batching input, analyzing data, etc.

35. Send your dp manager to an office automation conference.

36. Send your financial officer to an office automation conference.

37. Put a video projector in your boardroom. Use it in group meetings to project information (text, graphics) from your system.

38. Replace overhead foils with slides composed on the system. Have a forward, backward, and random access program created to simulate a slide projector.

39. Use an interactive text formatter/ editor for meeting support and minutes generation. Let all the participants see the on-line development of meeting notes and ideas.

40. Put an opinion registering device into your boardroom that can project votes and levels of agreement from the meeting participants on a screen. Use this to record votes in minutes.

41. For meetings that involve geographically distant participants, develop agendas and hold preliminary discussions over electronic mail. Make the time spent together in the meeting more focused and productive.

42. When you are ready to replace your phone system, include data switching support in the specifications. It will be there when you need it—at little extra cost.

43. Install all new terminals using the data module add-ons that go with your digital PBX. Save cabling costs and build a more flexible installation.

44. Instead of having the call detail recording output of your PBX printed on a printer, attach the output cable to an intelligent word processor or other computer. Use its listing, sorting, and merging facilities to prepare and print charge-back statements.

45. Tie the call detail recording output from your PBX into your client billing system.

46. Prepare your organization charts from the information in your personnel database (some reporting information may have to be added) With the addition of a simple graphics package, your charts will never be out of date.

47. Tie your organization charts into the addressing scheme of the electronic mail system. Permit addressing to staff positions (e.g., bookkeeping) and departments (e.g., sales managers).

48. Put everybody in your company on the electronic mail system, regardless of whether they have computer access. Deliver the messages to users without computer access through the mail system. Put a printer in the mail room, and users won't even have to concern themselves with the how the message gets there.

49. Next time one person finds it difficult to get to a meeting in another city, rent some audio teleconferencing equipment. Make sure the person leading the meeting is aware of how to conduct matters with an audio link.

50. Next time one group of people can't make it to an important meeting with another group in another major city, book the hotel teleconferencing facilities in the two cities. Use graphics as well as watching each others' faces.

51. For a series of meetings that involve geographically distant participants, lease or purchase some slow-scan video teleconferencing equipment. Using cheap and available telephone lines, the two or more groups in the meeting will still be able to see what is going on.

52. If you have an important user who is adamant about not using a keyboard, get a voice recognition device that can output the words it hears. Have him use it for the most frequent command words.

53. For your staff's next brainstorming session, rent some time on a computer conferencing system. Use it for the members of the meeting to raise issues and discuss ideas before the "actual" meeting.

54. Once you have demonstrated the advantages of computer conferencing, get a programmer or two to amend the electronic mail software so that it will support computer conferencing (it isn't really that big a change).

55. Start using a calendar scheduling system for meeting rooms. Take all the resources needed for meetings (rooms, projectors, etc.) and create them as entities in a scheduling system. Let the facilities coordinator maintain the information, but let users who are already on the system inspect the schedules themselves.

56. Once you have people using the system (or asking their secretaries to use it for them), start putting meetings and other shared activities on the scheduling system. Let people get used to the system suggesting the next available times.

57. If there isn't one already, build a link between the scheduling system and the messaging system. When a meeting is scheduled, the messaging system automatically informs the participants.

58. Put public and private reminders into the messaging and calendar system. Notify users of holidays, personal items (such as anniversaries), and other important dates.

59. Equip the messaging system with a timer. Let users send messages at specific times, or repetitively (reminders for weekly meetings, for example).

60. When you replace slower forms of text preparation with faster ones (word processors), use some of the secretary's or typist's time for more careful proofreading or other extra-skill tasks. Use the changes to create more interesting jobs.

61. As more of the secretary's time is saved using the office system support, increase the scope of the job description. Let talented secretaries become paraprofessionals, regardless of the type of business.

62. If you have very little in the way of computers or terminals to build a system on, start a new way of doing things with a voice messaging system. If you can't push the vendors into hooking one into your PBX (so it acts like a telephone answering machine) either buy or timeshare one of the standalone ones.

63. If you're experiencing a proliferation of one brand of microcomputer, get a local network from either the vendor of the micros or a third party Hook all the micros together, and encourage users to share files instead of copying them.

64. If a local net is not feasible, use a dial-in central computer for file and software distribution to the micros.

65. Add electronic messaging to the local network of micros.

Office Automation: The Next Generation

By: John J. Connell

Business literature is filled with predictions about how modern technologies will change the office. Those predictions are true. Whether one labels the phenomenon office automation, advanced office systems, the integrated office or the office of the future, the explosion in new office technologies will make tomorrow's office far different than today's.

But technology may prove to be a secondary importance. When we look back five years from now, we may well find that the primary agent of change in the office was the recession. Today's economics doldrums are forcing management to pursue alternative courses of action. Contingency plans are being activated, operating objectives are being re-evaluated, product lines are being trimmed, marginal plants are being closed and a host of other options are being pursued to adapt enterprises to the demands of today's economy.

What of the office where the majority of employees work and most of the payroll dollars are expended? Are contingency plans being activated? No, they are not because there are no contingency plans for the office. Are office operating plans being revised to meet new business requirements? No, there are no office operating plans or if there are they bear little relationship to business plans. Are the operating objectives of the office being reviewed and revised as necessary? No, because the operating objectives of the office have seldom been properly defined.

The recession is revealing how little control management really exercises over the office and how few options are available in times of adversity. When the very survival of the enterprise may be at stake, the only options that management can come up with to control office costs are to freeze salaries, cut travel budgets and reduce discretionary expenses by some arbitrary percentage—bromides that have to date back to the Middle Ages. Is this the best we can do? Can the fastest growing and certainly one of the most costly sectors of the enterprise only be controlled by reverting to such timeworn, simplistic programs?

Recessions call for new approaches, not only to cope with current economic conditions but also to position the enterprise for future growth. The office is no exception. New approaches to the management of the office will have to be developed in the near term even though those approaches challenge the status quo and call for new approaches, new organizational structures, new disciplines and new measures of performance. The recession has illustrated quite dramatically the inadequacies of today's approach. The office of the future must be managed with the same level of sophistication and perhaps with the same techniques that have worked so successfully in the line side of the business—establishment of clear-cut goals, development of operating plans which relate to business objectives, identification of performance measures, introduction of accounting systems designed to track performance and similar practices.

It is in this context that office automation is moving into the next generation. The term generation does not reflect a new wave of equipment advances although such advances are constantly taking place. Rather, it reflects a new role for office automation as a tool in a senior management-directed effort to improve the effectiveness of office operations.

The first generation of office automation can be characterized as one of advocacy. Proponents of new technologies, both vendors and users, devoted substantial amounts of time to promoting the use of new machines. The advocacy usually came from specialsts far down in the organization and paid little attention to the need for an overall equipment strategy or a business framework within which such advocacies could be properly evaluated. Given the lack of performance measures in the office, equipment had to be justified based on clerical savings, which were increasingly hard to find, or on saving managerial and professional time, which could only be measured in soft dollars. In many cases, the equipment was acquired on faith.

The second generation of office automation takes a different and far more businesslike approach. It looks on office automation as a set of tools for management to use in an effort to improve the way offices operate. It postulates that the office should be looked at as an economic entity whose purpose is to accomplish a stated set of objectives according to a well-thought-through business plan. The plan attempts to optimize the mix of people, ma-

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chines and facilities to meet the objectives of the office. Office automation equipment is evaluated and introduced within the framework of the plan.

The key to the second generation approach to office automation is that it is top-down. Primary responsibility for office automation activities is no longer relegated to technology advocates. Rather, it is assigned to those who are concerned with introducing more sophisticated management practices into the office. The requirements of the business become the driving force rather than fascination with the technology.

At first, this change will be somewhat traumatic to those in the office automation community. The technological elitism which was for years the hallmark of the data processing community is now showing up in word processing, micrographics, electronic mail, telecommunciations and similar areas. The second generation of office automation calls for this elitism to be subordinated to the requirements of the business. Efforts to introduce this philosophy into data processing have met with resistance and the same will probably occur with other technologies. On the other hand, the long term benefits to technologists and users alike of participating in a senior management-directed effort to improve the effectiveness of the office far outweigh the loss of technological mystique.

The recession, then, with all of its traumas, may turn out to be a blessing in disguise. It will if it causes senior management to become concerned about rising office costs and frightened at the lack of effective management control over office operations. It will if senior management uses it as a means of regaining control of the office and introducing more sophisticated management practices into that sector of the enterprise. It will if all of us recognize that office automation only provides the tools. What is needed is new approaches to managing tomorrow's office.

John J. Connell is the founder and executive director of the Office Technology Research Group, a Pasadena, California-based association of managers from large corporations in the United States, Canada and the United Kingdom who are concerned with planning for the future office. He is a well-known writer and speaker on the subjects of productivity, technology and people in the office.

Managing Information In Tomorrow's Office

By John J. Connell

These major developments are interacting to make tomorrow's office different from today's: (1) the office itself and how it is managed, (2) the explosion in technologies and (3) the need to manage information. The role of the office in the enterprise, how it is organized and managed, what people do in it, how they are equipped and how their performance is measured will change drastically over the decade.

The first development is a result of the recession. In times of economic adversity, senior management activates contingency plans, closing marginal plants, trimming product lines, modifying operating objectives and pursuing other options to adapt the enterprise to changing requirements. In the office, however, there are no contingency plans, nor clear-cut operating objectives nor operating plans that relate to business plans. The office is not subjected to the rigorous disciplines characterizing the management of line operations.

As a result, senior management is discovering that the only retrenchment option available for the office is to fall back on practices such as freezing salaries, cutting travel budgets and reducing discretionary expenses by an arbitrary percentage. Yet the office, over which management exercises so little actual control, now includes the majority of the work force and accounts for a disproportionate share of payroll dollars. Further, by almost any measure, its impact on the bottom line is accelerating.

These facts are being addressed. Senior executives realize that the approach to office management must be reexamined. The mission of the office must be more clearly defined, its organization structure must support that mission, operating goals and plans must be developed, performance measures must be established and accounting systems devised to track performance. The same kinds of management practices that worked so successfully in the line side of the business must be introduced in the office.

"Senior executives realize that the approach to office management must be reexamined . . . clearly defined and developed, and performance measures established . . .

JOHN J. CONNELL is executive director of the Office Technology Research Group, Pasadena, Calif.

One could go on at length about the capacities and capabilities of business systems and their improving economics. Of greater importance is an analysis of where the world of office technology is going. Several trends can be identified.

For example, the traditional separateness among technologies is blurring, as data processing can be handled on word-processing equipment and vice versa, as these functions interface with micrographics equipment and similar developments. Is electronic mail a word processing, telecommunications or data-processing application? In fact, it is none of these. It is one of a growing number of functions that cannot be labeled in traditional terms but must be grouped under an umbrella term such as information technology.

The significance of this trend is apparent in view of institutionalized technological separateness, with data-processing departments, word-processing centers, micrographics units and the like. Trade associations and professional societies develop on technological separateness, as do other elements of the technology infrastructures. Eventually, these institutions must change, because the separateness doctrine on which they are based will become invalid.

Another trend involves interconnection of business technologies through telecommunications networks. From it will emerge operating considerations that will form the basis of new organization structures.

Rather than organize around separate technologies one could envision an organizational strategy based on how best to provide technological support to office-based personnel. One component of that strategy could address the need to maintain a storehouse of machine-based information, a central repository from which everyone can draw.

Another component must address the question of how the powers of technologies are delivered to office-based personnel. The physical part of this delivery system could well be a network. The enabling part, however, is a continuing educational effort to facilitate equipment use. This introduces a new user community, the entire office. Technology is no longer confined to the exclusive preserves of the technologists. It is everywhere. Systems become tools to help do a job, to be used as one sees fit in the ordinary course of daily activities.

Not to be overlooked is the introduction and acceptance of personal computers. We do not have to wait for networks to be developed to enjoy the capabilities available in inexpensive personal computers. Resistance to technology by managers and professionals is fading as these devices proliferate. Eventually, personal computer users will demand telecommunications interconnection to central computers and access to the information stored there.

We are rapidly becoming an information society, with predictions that information will provide tomorrow's competitive edge. Information is the primary product of the office and the medium with which the technologies work. Office-based personnel spend most of their time acquiring, manipulating, storing, retrieving and disseminating information.

As the value of information increases, those activities take on greater importance. A serious effort to improve the management of the office and manage the introduction and use of advanced technologies must address the question of how best to meet information needs.

At present, information is not managed. Various groups stake claims that relate to their particular disciplines, but there is no comprehensive approach to information management.

Corporate librarians identify themselves as information managers, but their information base, for the most part, is external to the corporation. Records managers like to think of themselves as information managers, yet their primary orientation is toward paper and microfilm records retention. Data-processing personnel declare themselves as information managers, yet their information base consists of data stored on central computers, which represents a small portion of the information flowing through a corporation. Word-processing personnel identify themselves as information managers, although their information base is limited to text.

". . . Trade associations and professional societies develop on technological separateness, as do other elements of the technology infrastructures. Eventually this must change, because the separateness doctrine . . . will become invalid."

Most information in a corporation does not reside in machines, at least in a machine-readable sense. Responsibility for the management of that information is in the hands of those who use it.

What has to emerge is a new set of disciplines concerned with all information, how best to organize and structure information for easy access and use, how best to relate the value of information to its cost, how to meet privacy requirements, ensure validity and authenticity, minimize redundancies and a host of other issues.

The occupations of library science, records management, data-base management, text management and many others are part of this new discipline of information management. It is not a technology and should not be under the control of technologists. It is a separate and distinct area of activity of vital importance to the success of the enterprise.

These are the major developments that will change tomorrow's office. They are concerned with management, technology and information. More important, they are concerned with the people who work in offices. Since practically every manager has an office component to be concerned with, efforts to improve the way offices are managed will have a direct impact on that individual. If office technologies are in our workplaces, then each of us is directly affected.

Information is our brain food, and if it can be presented to us in a timely and effective manner, we benefit. Because of this direct, personal impact on us, we must involve ourselves in managing the process of change. The assignment cannot be left to technologists and specialists. Each manager and professional must participate in the effort because the office of the future is our future. IO

Information As a Resource

Harlan Cleveland

In a remarkably short span of about 10 years, the once prescient notion that industrial society was being transformed into a "post-industrial," "information," or "knowledge" society has become a cliché.

We are already past the jaw-dropping, gee-whiz stage of technological wonder, and have internalized, even if most of us do not really understand, the prospect of trillions of transactions performed in nanoseconds of time. But we have not yet gotten very far in learning how to think about the implications of the information society's technical wizardry for the way we live, work, and play. The hardware can come up with the *answer* in seconds and communicate it around the world in minutes, but have we asked the right *question?*

Part of the problem in considering these questions is that we're still struggling with definitions of basic terms, including the very word *information*. The hierarchy suggested long ago by T.S. Eliot in *The Rock* is a useful starting point: "Where is the wisdom we have lost in knowledge? Where is the knowledge we have lost in information?"

In my lexicon, *information* is the ore, the sum total of all the facts and ideas that are available to be known by somebody at a given moment in time. *Knowledge* is the result of somebody applying the refiner's fire to the mass of facts and ideas, selecting and organizing what is useful to somebody. Most knowledge is expertness—in a field, a subject, a process, a way of thinking, a science, a "technology," a system of values, a form of social organization and authority. *Wisdom* is integrated knowledge—information made super-useful by creating theory rooted in disciplined knowledge but crossing disciplinary barriers to weave into an integrated whole something more than the sum of the parts. (The distinction between information and knowledge—or knowledge and wisdom—is, of course, subjective. One person's information may be another's knowledge; one person's wisdom may be another's wisecrack.)

> The resources of the industrial age were tangible *things* that could be mined, processed, bought, sold, managed—and easily understood. In the emerging post-industrial society, there is little understanding of the characteristics of information—the basic, yet abstract, resource.

It is probably not important to search for universal agreement on the distinctions between knowledge, information, and wisdom. There are many ways to make these distinctions, each of which can help clear intellectually muddied waters in certain contexts. Daniel Bell defines information as "data processing in the broadest sense" and knowledge as "an organized set of statements of facts or ideas . . . communicated to others."

A colleague at the University of Minnesota, Yi-Fu Tuan, organized the T.S. Eliot hierarchy this way:

> . . . The difference is one of order of complexity. Information is horizontal, knowledge is structured and hierarchical, wisdom is organismic and flexible. Any diligent student can, with the help of a computerized system, acquire vast amounts of information; for instance, the population of every township in the United States. But the data are pretty useless because they are stretched out at one level. (Information is horizontal.) For the data to be useful—come to life, as it were—they have to be linked to another rung or category of data. The result is knowledge. (Knowledge is structured and hierarchical.) Every teacher knows how difficult it is to pass knowledge, as distinct from information, to students; hence, we give objective tests to determine how much information, rather than knowledge, they have acquired. As for imparting wisdom, it . . . has to do with personal chemistry and slow osmosis.

The "Informatisation" of Society

While we may not agree on precise definitions, we can probably take as common ground the size and scope of the transition we are in: the "informatisation" of society. (The new word rolls off the tongue more readily in French than in English.) Both the size and scope are impressive, if still largely impressionistic:

- A century ago, fewer than 10% of the American labor force were doing information work; now more than 50% of us may be engaged in it. The actual production, extraction, and growing of things now soaks up less than a quarter of our human resources. Of all the rest, which used to be lumped as "services," perhaps two-thirds are information workers.
- It is not only in the United States that the informatisation of society has proceeded so far so fast. A recent study by the Organization for Economic Cooperation and De-

velopment puts the average information labor force of several of its member countries at one-third of the total during the early- to mid-1970s. That same study indicates that the information component of the labor force increased its share of the total by 2.8% during each five-year period since World War II.

In this computerized office, information has become the key resource. The informatisation of society, represented by automation in factories and offices, will require a transformation of the labor force, says author Cleveland. While 100 years ago fewer than 10% of the U.S. labor force were in "information" services, as many as 50% may be engaged in them today.

- While having fewer laborers in production and more in services is not new, what is new is the pace of change made possible by the converging revolutions of computers and telecommunications along with the dawning mass realization that something very large and important is occurring under our very noses. When a much-read philosopher of business administration such as Peter Drucker starts calling knowledge "the central capital, the cost center, and the crucial resource of the economy," non-philosophers preoccupied with the managing of organizations have to sit up and take notice.

My University of Minnesota colleague G. Edward Schuh says, "All of the increase in agricultural output from the mid-1920s through the mid-1970s (a 50-year period!) came about with no increase in the capital stock of physical resources. It was all due to increases in productivity, with most of that due to new knowledge or information. That makes clear the extent to which knowledge is an input or resource."

- What is also new is a theory crisis, a sudden sense of having run out of basic assumptions. We have carried over into our thinking about *information* (which is to say symbols) concepts developed for the management of *things*—concepts such as property, depletion, depreciation, monopoly, market economics, the class struggle, and top-down leadership. But as Simon Nora and Alain Minc say in their report to the president of France: "The liberal and Marxist approaches, contemporaries of the production-based society, are rendered questionable by its demise." The assumptions we have inherited are not producing satisfactory growth with acceptable equity either in the capitalist West or in the socialist East. Maybe it would help if we stop treating information as just another *thing*, and look hard at what makes it so special.

If information is a resource, it is unique among resources. The resources I learned about in school were tangible: minerals, fuel, food. During my career in the U.S. government, I helped buy and sell resources for the Board of Economic Warfare, transferred resources to other countries through the Marshall Plan and the early foreign-aid programs, argued about "sovereignty over national resources" in U.N. committees, and helped mobilize resources for defense in NATO. In these and other assignments I have brought people ("human resources") together in organizations to manage things and to manage ideas about things. We never said "to manage information."

We have grown up thinking of business as built on resources-as-things. But the physical component of most business now is a small base for an inverted pyramid of organized information. Most people in business now work on ideas, procedures, marketing, advertising, administration, and trying to stay out of trouble with the consumers, the regulators, and the law.

By the same token, the American labor movement was built by and for people who worked with things; its main power base is still in automobiles, steel, freight transportation, metal-working, and other crafts. But thing-oriented work is now the province of a dwindling minority of the U.S. labor force. More and more of the organized workers, and the great bulk of the unorganized, are working in services, and most of the service employees are in information work.

The Characteristics of Information

If information (through being refined into knowledge and wisdom) is now our "crucial resource," what does that portend for the future? The inherent characteristics of information now coming into focus give us clues to the vigorous rethinking that must now begin:

1. Information is expandable. Some information for some purposes is certainly depletive over time—yesterday's weather forecast is of merely historical interest tomorrow—but for the most part, as John and Magda McHale were already saying a decade ago, information expands as it is used (see John McHale, *The Changing Information Environment*, Westview Press, 1975). Whole industries have grown up to exploit this characteristic of information: scientific research, technology transfer, computer software (which already makes a much bigger contribution to the GNP than the manufacture of computer hardware), and agencies for publishing, advertising, public relations, and government propaganda to spread the word (and thus to enhance the word's value).

Because information is expandable without any obvious limits, the facts are never all in—and facts are available in such profusion that uncertainty becomes the most important planning factor. The further a society moves toward making its living from the manipulation of information, the more its citizens will be caught up in a continual struggle to reduce the information overload on their desks and in their lives in order to reduce the uncertainty about what to *do*. In the information society, we trade glut for scarcity, flood for drought. To find that our "crucial resource" is not scarce does not mean that life will be easier. But it certainly will make life different.

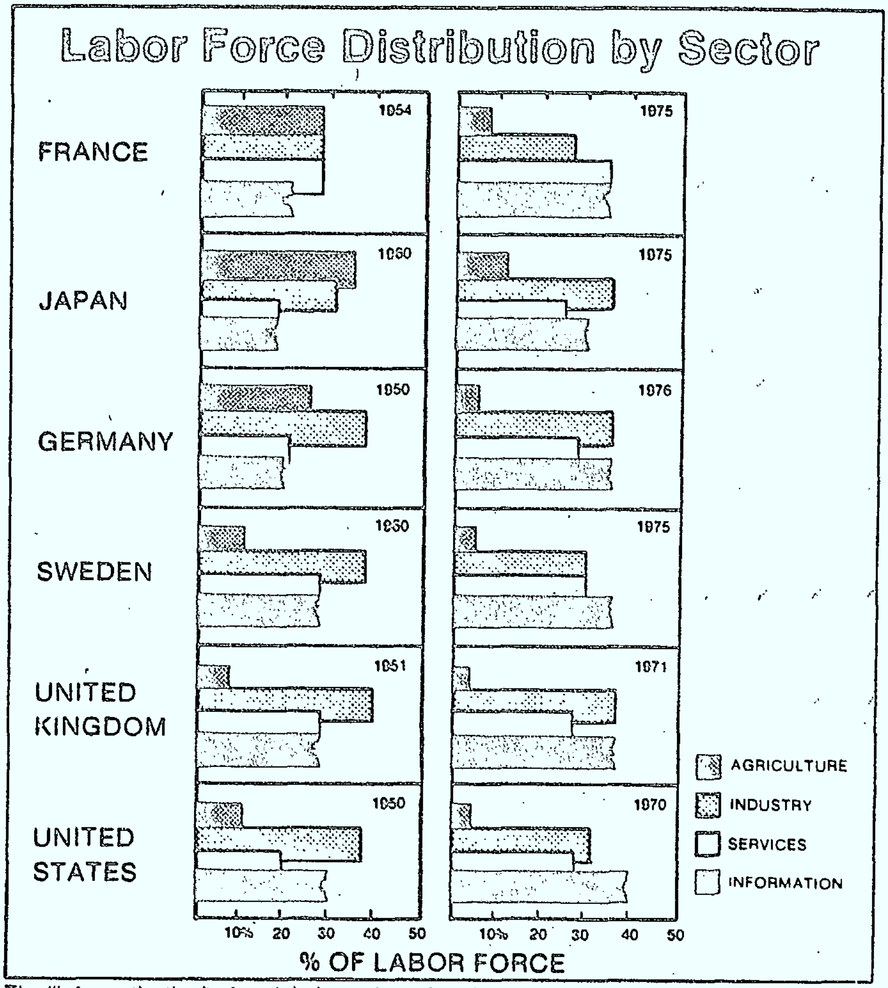
The ultimate "limits to growth" of knowledge and wisdom are *time* (time available to human minds for reflecting, analyzing, and integrating the information that will be "brought to life" by being used) and the *capacity* of people—individually and in groups—to analyze and think integratively. There are obvious limits to the time each of us can devote to the production and refinement of knowledge and wisdom. But the capacity of humanity to integrate its collective experience through relevant individual thinking is certainly expandable—not without limits, to be sure, but within limits we cannot now measure or imagine.

2. Information is compressible. Paradoxically, this infinitely expandable resource can be concentrated, integrated, summarized—miniaturized, if you will—for easier handling. We can store many complex cases in a single theorem, squeeze insights from masses of data into a single formula, capture many lessons learned from practical experience in a manual of procedure. By selecting and compressing information to produce knowledge and wisdom, some information is bound to be lost; what is lost may turn out to be trivial or merely interesting, but it could also turn out to be crucially relevant.

3. Information is substitutable. It can replace capital, labor, or physical materials. Robotics and automation in factories and offices are displacing workers and thus requiring a transformation of the labor force. Workers who have previously helped grow or extract or make things, or who have been in the non-information services, will have to learn to become information workers—or get used to being unemployed. This transformation may affect up to 45 million workers by the year 2000, according to Senator Gary Hart in a speech to the World Future Society Assembly on "Communications and the Future."

4. Information is transportable—at the speed of light and perhaps, through telepathy, faster than that. In less than a century, we have been witness to a major dimensional change in both the speed and volume of human activity, a change in transportability of resources greater than the multi-millennial shift from foot travel to supersonic jets.

"More and more of the organized workers, and the great bulk of the unorganized, are working in services, and most of the service employees are in information work."



The "informatisation" of society has taken place in many advanced countries. A study by the Organization for Economic Cooperation and Development puts the average information labor force of several of its countries at one-third of the total.
Source: Organization for Economic Cooperation and Development, *Information Activities, Electronics, and Telecommunications Technologies: Impact on Employment, Growth, and Trade*, pg. 29

5. Information is diffusive. It tends to leak—and the more it leaks the more we have. Information is aggressive—even imperialistic—in striving to break out of the unnatural bonds of secrecy in which thing-minded people try to imprison it. Like a virus (which is itself a tiny information system), information tries to affect the organisms around it—whether by over-the-fence gossip or satellite broadcasting. The straitjackets of public secrecy, intellectual property rights, and confidentiality of all kinds fit very loosely on this restless resource.

6. Information is shareable. Shortly before his death, Colin Cherry wrote that information by nature cannot give rise to exchange transactions, only to *sharing* transactions. *Things* are exchanged: if I give you a flower or sell you my automobile, you have it and I don't. But if I sell you an idea, we both have it. And if I give you a fact or tell you a story, it's like a good kiss: in sharing the thrill, you enhance it.

A New Kind of Resource

The information resource, in short, is different in kind from other resources. So it has to be a mistake to carry over uncritically to the management of information those concepts that have proven so useful during the centuries when things were the dominant resources and the prime objects of commerce, politics, and prestige. These concepts include scarcity, bulk, limited substitutability, trouble in transporting them, and the notion of hiding and hoarding a resource.

A society in which information is the dominant resource is not necessarily "better" or "worse," fairer or more exploitative, cleaner or dirtier, or happier or unhappier than agricultural or industrial societies in which physical, tangible resources are dominant. The quality, relevance, and usefulness of information are not givens. They depend on who uses the information, in how refined a form, and for what purposes.

Implications for Human Life

The implications of treating information as a resource are enormous, for life-styles and workways, for human community and inhuman conflict.

The implications, I believe, are especially great for changes in the way we think about life, work, community, and conflict. The theories (assumptions, preconceptions, ideologies, call them what you will) we develop will arrange "the facts" and determine how we resolve, for our time and place, the historic social dilemmas—freedom vs. organization, autonomy vs. authority, participation vs. action, growth vs. equity, war vs. peace.

If our dominant resource is now expandable, compressible, substitutable, highly transportable, diffusive, and shareable, what are the implications for some of our favorite and predominant theories and assumptions?

• In political economy, won't the concept of market "exchange" have to take account of the fact that more and more of our economic activity now consists of what are by nature "sharing" transactions?

• In economics, why are we still focusing on the allocation of scarcities when there is a chronic surplus of information resources?

• In law, how should we adapt the concept of property in facts and ideas when the widespread violation of copyrights and the shortened life of patent rights have become the unenforceable Prohibition of our time? Aren't we going to have to invent different ways to reward intellectual labor that are compatible with a resource that is both diffusive and shareable? Aren't the laws governing privacy and the regulations governing telecommunications already outmoded by technology, which does not wait around for legislative hearings or court calendars?

• In accounting, what are we to do with a concept called "depreciation" in a society where a large fraction of its resources does not depreciate with use?

• In education, doesn't the information environment place a much greater premium on integrative thought? Won't we have to take a new look at a system that awards the highest credentials for wisdom to people with the narrowest slices of knowledge? And as the education required to be functionally literate in an information society keeps growing in depth and breadth, what is to become of those who, because they lack basic education or the opportunity for continued learning, become the peasants of the knowledge society?

In the new information environment, we will have to rethink the very nature of rule, power, and authority because the information revolution is producing a revolution in the technology of organization.

Information has always been the basis of human organization, of course. People with better or more recent information—generals with fast couriers, kings with spies and ambassadors, etc.—held sway over the rest of mankind. But once information could be rapidly collected and analyzed, instantly communicated, and readily understood by millions, the power monopolies that closely held information made possible were subject to accelerating erosion.

Leadership of uninformed people was likely to be organized in vertical structures of command and control. Leadership of the informed is more likely to result in effective *action* if it is exercised mainly by persuasion, with wider participation and more collective thought.

With nobody completely in charge but everybody partly in charge, collegial rather than command structures are the more natural basis for organization. "Planning" cannot be done by a few leaders, advised in secret by experts with detailed blueprints; "planning" has to be a dynamic improvisation by the many according to a general sense of direction that is announced by "leaders" only after genuine consultation with those who will have to improvise on it.

Participatory decision-making implies a need for much feedback information, widely available and seriously attended. That means more openness and less secrecy—not as an ideological preference but as a technological imperative. In the Information Society, maybe that's the updated definition of democracy.

About the Author

Harlan Cleveland, political scientist and public executive, is professor and director of the University of Minnesota's Hubert H. Humphrey Institute of Public Affairs. He has also served as dean of the Maxwell School of Citizenship and Public Affairs at Syracuse University, assistant secretary of state for International organization affairs, U.S. ambassador to the North Atlantic Treaty Organization, president of the University of Hawaii, and director of the Aspen Institute's Program in International Affairs. The Hubert H. Humphrey Institute is currently mounting a program of policy research on the theme of "Information As a Resource."

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office technology research group

Information Resource Management

by

John J. Connell
Executive Director

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Information is everybody's business and, paradoxically, it is nobody's business. Managers and professionals in corporate life are keenly aware that the quality of their performance depends upon the timely availability of pertinent, comprehensive information. They find themselves frustrated, however, that their information needs are not being met.

The problem is not the lack of information; in fact, just the opposite. Thanks to high-speed printers, convenience copiers and bulk mailing rates, today's managers and professionals suffer from an overload of information, most of which is irrelevant. Trying to wade through the morass to find key answers is next to impossible. As a result, professionals analyzing alternative courses of action and managers faced with making operating decisions are being stymied by a dearth of good information.

We are moving from an industrial age to an information age, one where most people will be working on jobs that involve the production or the use of information. Having the right information at the right time can be the competitive edge

The right information can provide the competitive edge, but managers are overloaded with irrelevant information.

One would assume that special management efforts are employed to assure that every manager and every professional is supplied with all the information necessary to do his job. This is not true. Senior management pays little attention to the problem of meeting information needs. Instead, the assignment is turned over to staff specialists, and the results are mixed, at best.

Information may be vital to everybody's business but, when it comes to management, it is nobody's business.

Two developments, occurring almost simultaneously, now offer senior management a unique opportunity to come to grips with the information problem. The first is the need to improve productivity in the office. The second is the concept of information resource management.

Productivity Improvement

Historically, senior management has ignored office operations. At last, this attitude is changing. The catalyst is the growing recognition that office costs are rising precipitously, faster than in any other sector of business operations.

Senior managers, concerned about the potentially adverse impact of office costs on company profits, are instituting formal programs to improve office productivity. These programs are not being aimed at clericals. The target is the managerial and professional work force which accounts for almost 75% of all office costs.

The programs have three strategy steps: to establish productivity improvement as a corporate goal and set in motion those programs and policies necessary to build that philosophy into every facet of corporate life; to get everyone personally involved in the productivity improvement effort through quality circles, incentive programs and similar activities; and to take full advantage of the potential of new office technologies.

While directing these productivity improvement efforts, senior managers have discovered that nobody

Senior managers are instituting productivity improvement programs because of rising office costs.

manages today's office. Managerial assignments relate to departments, to systems and to functions, but no entity or individual short of the chief executive officer is responsible for managing office operations. As a result, the management practices which work so successfully in line operations are employed haphazardly in the office, if at all.

The key question to be asked in any effort to improve the productivity of a given operation is whether the operation should be performed in the first place. When that question is asked in the office, however no clear answer is forthcoming

The full benefits of productivity improvement programs are seldom attained because the office is task-oriented rather than goal-oriented

Information Resource Management

The need to improve productivity is one development affecting the office. The other is information resource management, the concept that information should be looked at as a corporate resource, and managed accordingly.

However, the concept has been slow in gaining acceptance, because it has not been widely publicized. It developed in the information-processing community and has been advanced primarily in terms of its impact on that field and on the career aspirations of information processing personnel

John J. Connell is the founder and executive director of the Office Technology Research Group, Pasadena, CA, and a well-known author and speaker in the Office of the Future field.

Efforts to explain the concept to senior management have not been successful. Visualizing an intangible, such as information, as a resource with bottom-line implications is very difficult. Considered by itself, the concept appears to be too theoretical, a dubious justification for making substantive changes in business operations.

Some of its advocates cloud the picture further by equating information resource management to information control. They contend that the only way to reduce information overload is to set up an individual or an entity to determine who gets what information and when. The Big Brother implications of such an approach are anathemas to most managers.

Conceptually, information can be looked at as a corporate resource and managed like other resources.

Yet the concept does have merit, at least as a means for addressing the information problem. Information is an important corporate resource. In fact, one could argue that it is the premier corporate resource because it is used in the management of all other resources.

Managing the Office

Any effort to improve office productivity must concern itself with information. By melding the information resource management concept into the office productivity improvement program, senior managers can introduce into the office the expertise they have used so successfully in the line side of the business. Not all of that expertise is directly transferable, but much of it is.

If information is looked on as the product of the office, then cost/benefit analyses can be made of activities involved in acquiring, processing and moving the product. Goals can be established based on product requirements and alternative courses of action evaluated in terms of those goals. Organization structure can be designed to reflect the requirements of producing the product. Capital investment proposals can be compared with those coming from line units using common return on investment criteria. In short, perhaps for the first time, the office can be managed.

Molding information resource management into office productivity programs will improve performance.

The task is not simple. Information is hard to define, not easily valued, and far different from the products ordinarily dealt with in the plant or in the marketplace. Introducing value analysis and return on investment philosophies into an area that traditionally has been oriented to full service is a formidable assignment. The bureaucracy of the office, with its independent fiefdoms, adds to the problem.

But the opportunity is there. Never has the office been confronted with so much change—the growing sophistication in information demands, the extraordinary explosion in new office technologies, the changing nature of the office work force and the desire, in fact, the pressing need to improve office productivity. The way these changes are managed will determine the economic viability of the office in the years to come and the caliber of its contribution to the success of the enterprise.

Management Responsibility

Experience with productivity improvement programs has validated the thesis that such efforts should be led by senior management. The top-down approach ensures that the programs receive proper visibility, that everyone is encouraged to become involved and that present organizational structures do not become stumbling blocks.

In exploring how best to combine the information resource management concept with office productivity improvement programs, the same philosophy applies. The effort should be led by senior management, and its mission should be to develop a philosophical underpinning for introducing better management into office operations.

Senior managers should lead and every manager should participate in managing the information resource.

That managers and professionals are responsible for identifying their own information requirements and deciding how information should be used sounds simplistic—a rudimentary expression of a management principle.

In practice, however, many managers and professionals have limited skills in defining their information needs. In fact, the criticism that computers produce reams of largely irrelevant reports should not be laid exclusively at the feet of computer systems designers. In most cases, the root cause is the inability of managers and professionals to specify their own information requirements, to decide what information they need and what they do not need. As a result, computer-generated reports represent what systems designers think managers need.

Knowledge workers must identify their needs and use information correctly, or fail.

In an information age, however, knowledge workers who cannot identify their information needs and use information correctly will fail. As will be shown later, new information technologies help managers obtain operating information directly from machines. Current literature cites cases where chief executive officers are using terminals to access computer-stored performance information. The emphasis is on interfacing directly with the information base rather than relying on the services of staff specialists.

A strategy for introducing the information resource management concept should insist that every manager and professional participate in the management process. It should also support that participation with education and hands-on experience. By stressing that direct role, senior management can reduce the chance of knowledge workers failing in their assignments and enhance the opportunities for superior performance. Information specialists make their greatest contribution by using sophisticated machines to acquire, process, move and store information. But managing the acquisition, processing, movement and storage of information should not be equated to managing the information resource. The talents of information specialists from many disciplines combined with the capabilties of modern machines are key determinants in meeting the information needs of managers and professionals. In the final analysis, however, corporate success will depend on how well information requirements are specified and how well the information is used

Information Technologies

The level of understanding required of managers and professionals about what is happening in information technologies should be deep enough to appreciate the implications of new developments as they are introduced.

These developments have two objectives to find more cost-effective ways to acquire, process, move and store information, and to provide tools to help make better use of machine-stored information.

Understanding these developments, at least conceptually, is vital to effective management of the information resource, because one can envision no greater change in the years ahead than will occur in the world of information technology and all that it affects.

The traditional way of looking at information technologies is to track their historical development Data processing grew from punched card equipment in the 1950s to electronic computers in the 1960s to the large datacenters we know today.

Word processing came on the scene in the 1960s in the form of typewriters with magnetic tape storage and grew to the almost overwhelming array of text-editing equipment on today's market.

Micrographics, one of the oldest technologies still extant, has been allied with computers to become one of the most modern technologies.

In fact, the historical approach is reflected in the way the information industry is organized and in the organizational strategy of most corporations. We have organized ourselves around technologies as they have developed historically, and the separateness of technologies has been institutionalized.

Information technologies are changing and the distinctions among them are blurring.

All that is about to change. Two developments, operating in concert, will revolutionize the whole world of information technology. The first is the changing of traditional definitions of specific technologies and the blurring of distinctions among them. The second is the interconnection of previously separate technologies through integrated telecommunications networks. These two developments will eventually lead us to one information technology, the integrated network. The machines we know today, or their successors, will be components of the network.

Data Processing

Data processing is a good example of this process of change. In the 1960s and 1970s, computers were installed in centralized datacenters which provided computer services and processed data in accordance with the instructions programmed into various systems. Orderliness, structure and tight control were the key elements of the approach. Most of the standard accounting systems, payroll, billing and the like, were converted to computers in this environment, and those applications are handled in centralized datacenters to this day.

The appearance of minicomputers in the 1970s introduced some new options. The centralized approach to computing was augmented by the introduction of local computers. Machines began to lose their mystique, and computers became tools for use in the workplace rather than exclusively in the datacenter.

As the use of minicomputers proliferated, a new term was coined—distributed processing—to describe the movement of computing power out of the hands of the information specialists in the datacenter and into the office. The movement was resisted by the data processing community at first, but the approach has proven successful. The more astute data processors are now strong supporters of a multi-tiered machine strategy involving central computers, minicomputers and systems which use telecommunications networks to move computer power to the end user's site

Distributed processing turned out to be a harbinger of things to come The basic trend in computing today is to devise better ways to make the technology available to non-technologists This trend has been accelerated by the introduction of personal computers which are appearing in homes and offices

Distributed processing turned out to be a harbinger of things to come.

Data processing personnel have had to cope with these changes over the years, and it has not been easy Computer applications are far more sophisticated and complicated than in the past. Payroll, billing and similar applications, which were transferred to computers years ago, now look like child's play compared to today's applications, which cross departmental lines, require on-line access, and use complex algorithms in the manipulation of information.

Of greater concern today, however, is the limited flexibility of most data processing departments in their ability to respond to new technological opportunities, especially those which apply to the people-intensive world of the office

Computer applications are more sophisticated and complicated than in the past.

Many of the systems in place on today's computers were designed when machine limitations and systems design philosophies combined to make systems changes very difficult. However, systems must change because of new business requirements, governmental regulations and other external factors. Industry surveys show that making changes in old systems, which is called systems maintenance, accounts for more than 60% of the systems design workload.

Most computer systems design organizations have a three-year backlog of work The pressure of such a backlog coupled with continuing changes in technology has led to high turnover and job burnout, thus inhibiting even further the ability to respond to the demand

Most computer systems design organizations have a three-year backlog of work.

arising from the introduction of new office technologies.

In looking to data processing to play a key role in introduction of the information resource management concept, senior management must recognize the changes which face that technology and the heavy workload and backlog it carries. Both may operate to limit the flexibility of data processing in responding to new technological challenges.

Word Processing

Computers process data which has been logically defined, according to a set of logical instructions programmed beforehand. Thus, the logical definitions of gross pay as hours times rate and net pay as gross pay less deductions are programmed into a set of instructions to produce paychecks. When one moves from data to text, however, to words, sentences and paragraphs, logical definitions do not work. Instead, text editing requires a human being to interpret the text and then to decide how it should be manipulated.

Word processing requires a direct, ongoing interface between a human and a machine.

This distinction is what makes word processing different from data processing. Data processing operates under control of a set of programmed instructions, with the human interaction one of monitoring. Word processing requires a direct, ongoing interface between a human being and a machine. The data processing and word processing machines may look alike, but because one operates on data and the other on text, they have developed separately as two independent technologies and industries

Word processing has progressed from the stormy period when its installation was justified by taking away the manager's secretary to instances where it is used to make the team of manager and secretary more productive In that setting, the secretarial time saved by transferring work to a word processor is filled with work transferred from the manager. The value of the additional work which the manager can take on justifies investment in the equipment.

Word processing can make the manager and secretary team more productive.

Latest developments on the low end of word processing equipment provide machines with full text-editing and spelling correction capabilities, at a price which often permits justification of the machine as a direct replacement for a secretary's typewriter.

Developments at the higher end signal the blurring of technologies, for word processing machines now come with data processing capabilities. They also act as computer terminals in providing access to the central computer over telecommunications lines.

Conversely, central computers and minicomputers are being equipped with software packages which give them full word-processing capabilities. Thus, the separateness of the two technologies, so staunchly defended in the past, no longer has a valid technological basis. The machines are what the user wants them to be, and the implementing mechanism is the telecommunications network.

Micrographics

Micrographics provides another example of the blurring of distinctions among technologies. Microfilm is a storage medium which has been in use for many years. In the past, it was associated with archives, an economically attractive alternative to paper for storing archival material. As time went on and microfilm rolls were supplemented by strips of microfilm in jackets and by microfiche, the medium took on a new role as a tool to be used in ongoing office operations.

However, because microfilm has different characteristics than magnetic storage mediums in terms of method of recording, accessibility and permanence, micrographics has been looked at as a completely separate technology. With the advent of COM equipment, however, which records *computer output* on *microfilm*, the separateness began to disappear. Today, many companies look on microfilm as another computer output along with paper and magnetic tape. In fact, the COM operation is often part of the data-processing function rather than the micrographics function.

CAR equipment makes microfilm an operationally viable alternative to magnetic storage.

The advent of CAR equipment, which uses a *computer* to *aid* in the *retrieval* of images stored on microfilm, blurs even further the old distinctions between these technologies. CAR equipment makes microfilm an operationally viable alternative to magnetic storage.

In the past, information was retained in magnetic form because of ease of access, even though that approach was very costly. Now, the improved access to microfilm images offered by CAR equipment allows one to augment magnetic storage with microfilm storage and enjoy substantial savings. Thus, both technology and economics are supporting the interface between computers and micrographics.

One could cite many other examples where the old definitions of one technology versus another are changing and the distinctions among technologies are blurring.

These changes are highly traumatic to information specialists brought up in and allied to any one technology. Organizational fiefdoms are threatened and career paths go awry. Questions about the future are frequent themes for discussion in the various technological communities. Data processing and word processing, the most mature and well-entrenched technologies, are both going through identity crises.

Data-processing personnel are finding it difficult to cope with the idea that computers are no longer the sole or premier office technology. Rather, there are many approaches to computing, and there are many information technologies besides computing, each with a role to play.

The impact of technological change on information specialists is traumatic.

Word-processing personnel are responding more positively to these changes by expanding the definition of their roles to that of information processing, handling both text and data.

Similarly, micrographics personnel are attempting to adapt by concerning themselves not only with micrographics but also with other approaches to image processing.

Business literature would lead one to believe that the greatest impact of new information technologies will be on managers and professionals. A strong case can be made that it is the information specialists themselves who will be most affected. Senior management should be aware of this phenomenon and factor it into the strategy to meld the information resource management concept into office productivity improvement programs

Networks

The second change taking place in information technologies adds to this uncertainty and, in fact, charts an entirely new course. That change is the trend toward interconnecting machines through telecommunications. In the final analysis, telecommunications is the basic underlying technology in the future office.

To complicate matters further, telecommunications is changing more rapidly and on many more fronts than any other technology. The literature is filled with news about telecommunications—the settlement of the AT&T anti-trust suit and what it means, the competition among suppliers of satellite-based transmission services; the advantages of digital versus today's analog long-distance network; the debate between broadband and baseband as the technique to be used in local data networks; computerized PBX's; "smart" telephones, the integration of voice and data, control over international data flows, and a host of others. Technological issues, political issues, regulatory issues and, of late, competitive issues mark the world of telecommunications.

In the future, all information-related machines will be interconnected through telecommunications.

The importance of telecommunications in the future office cannot be overstressed. Ultimately, every machine in an office which works with information will have built into it the ability to interconnect with a telecommunications network. Once connected, the machine will be able to share its capabilities with all other machines tied to the network.

From a user's point of view, tying into the network will provide access to information stored in the form of data on computers, text on word processors, images on microfilm and voice on the network itself. The network is the vehicle through which all the powers of modern technology are made available to the entire work force.

The network makes all the powers of modern technology available to the entire work force.

Consider this example of how the capabilities of machines can be enhanced and in some cases greatly multiplied by tying them to a network. Word-processing machines are used to produce letters which are then mailed. However, if the machines are tied to a telecommunications network and communicate with other word-processing machines, then letters typed in one location can be printed in another, thereby avoiding the time delays of mailing. Further, if a computer is connected to the network, it can make copies of letters, distribute them to addressees and retain file copies, all electronically. Finally, if microfilm equipment is attached to the network, the file copies can be converted to microfilm for archival storage. Access to a network, then, and to other machines tied to the network, upgrades the capabilities of the word-processing machines from letter production to a full-scale electronic mail system.

Electronic mail is a good example of the impact of networks on information technologies. It integrates four previously separate technologies—word processing, telecommunications, data processing and micrographics—into a single use, and it would be difficult to define where one starts and the other stops. An electronic mail system can be accessed at work, or at home, or while traveling—in fact, anywhere one can tie into the network with the proper terminal. Its usage is voluntary, based on perception of value.

Information specialists may view it as a word-processing application, or a data-processing application or a micrographics application, depending upon their bias. To the user, however, the manager or the professional, it is a capability available from the network. The future of information technology is summed up in that view, that the network provides an array of capabilities for managers and professionals to use to improve their performance.

An Array of Capabilities

The array of capabilities which networks will provide to managers and professionals is growing at an extraordinary pace. This growth stems from the synergism that occurs when one interconnects previously separate technologies and takes advantage of the powerful characteristics of each. Of even greater importance, the capabilities pour forth from the creative minds of designers in the software industry, the fastest growing sector in the information field.

Networks will provide managers and professionals with an array of capabilities to help improve performance.

The following is a description of some of the capabilities that are available to managers and professionals. They represent the first steps; additional work is needed to make them more universally available and easier to use. Nevertheless, the existence of these capabilities is a clear indication of forward directions, the move to introduce the powers of modern information technologies into the offices of every manager and professional

Electronic mail is the capability of receiving one's mail over a network, reading it on the screen of a terminal and using the terminal's keyboard to respond.

The distribution of copies to addressees, the maintenance of file copies and the ultimate disposal of the files are all handled by machine. Electronic mail is used for internal correspondence in a number of companies and some efforts are under way to use it for external correspondence to a select user community. Experience shows that casual users tend to send cryptic messages rather than formal letters, so the capability might more properly be called electronic messaging.

Voice messaging is a capability similar in principle to electronic messaging, except the terminal is a telephone and the message is spoken and played back rather than typed and read on a screen.

Telephone answering machines offer an entry-level form of voice messaging. More sophisticated machines have voice message distribution, filing and retrieval characteristics that are almost identical to those of electronic messaging. The use of voice message systems is growing rapidly because the terminal device, the telephone, is already in place and well-accepted. Also, the training necessary to use these systems is minimal.

Internal data base access is the ability to access information stored on the company's central computer, retrieve it selectively, structure and manipulate it as desired and produce personalized reports.

This capability has extraordinary potential and could have far-reaching impact on the managerial skills required for the future. For the most part, information stored on computers is not easily accessible to managers. To get selected information, one must describe one's requirements to a computer specialist who translates the request into a series of programs steps to access the computer file and produce the desired result. The process is cumbersome, time-consuming and frustrating.

For the most part, information stored on computers is not easily accessible to managers.

The prospect for the future is that managers will use a terminal to access computer-based files directly, quickly find the information they want and use it as they see fit, thus operating in a totally self-sufficient way. This new capability will change the traditional reliance of managers on staff specialists to obtain and analyze data. Some managers will choose to do their own research, and if superior results are obtained, others will also. Thus, the ability to define one's information requirements and make effective use of the information obtained becomes an increasingly important management skill.

External data base access is the ability to access information available from external sources. A growing number of firms now offer data base services, consisting of terminal access to a variety of files. Airline guides and stock quotations are obvious examples, but others include industry statistics, abstracts of published literature, current events and a host of others. Thus, the manager developing future plans can supplement company information obtained from internal data bases with information of the world outside.

The provision of computer-based information services will be augmented shortly by videotex, which provides similar services using television screens. The ultimate role of videotex in the information services field is still unknown. Current efforts to exploit its potential support the thesis that a growing body of information will be available externally, in various forms, all accessible by machine.

Access to text is the ability to access correspondence and reports which are stored in electronic form. The use of word-processing equipment to produce textual material is creating a growing repository of information in the form of text, which will be available for retrieval in similar fashion to data.

Information manipulation is the ability to manipulate information electronically in any way desired. If the information is in the form of data, a program can be written to manipulate it. If text, it can be manipulated directly on a screen by keyboard command. If a permanent record is required, the manipulated information can be printed out or transferred to microfilm. Thus, terminal-based access systems are not merely a mechanism for finding machine-stored information and displaying it on a screen. They offer a full range of capabilities for editing, structuring and manipulating the information in any way one desires.

Decision support systems provide the ability to simulate business decisions mathematically and predict the results that will occur from pursuing one course of action versus another.

The effectiveness of decision support systems depends upon whether the variables attendant upon alternative courses of action can be defined and quantified. Great success has been achieved in such areas as cash management and simulation of manufacturing plant operations where the variables are well-known.

Of late, significant results have been achieved in using decision support systems in financial planning, portfolio analysis, tax planning, market analysis and a number of other areas. As decision support systems can be made to interact with company data bases, they will become an increasingly important management tool.

Decision support systems will become an increasingly important management tool.

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Graphics is the ability to take information retrieved from machine storage and convert it to a graphic presentation mode—bar charts, pie charts, curves and other visual displays. The adage that a picture is worth a thousand words is demonstrated no more effectively than when columns of data extracted from a computer file are converted on a screen to a multi-dimensional color display. Graphics can expose the hidden relationships that exist in the data and at the same time present an overview from a new perspective.

Graphics expose hidden relationships in data while presenting an overview from a new perspective.

Microfilm access is the ability to retrieve images which have been stored on microfilm. The key characteristic of microfilm is that once information is recorded on it, the information cannot be manipulated. That, plus its low cost, makes it the ideal storage medium for incoming correspondence, contracts and related legal material, printed matter and other documents which one may wish to access but not change. Computer-aided retrieval capabilities facilitate access to information stored on microfilm.

Local administrative support describes the ability to use the storage, manipulation and retrieval capabilities of terminals tied to a network to aid in handling administrative tasks. Keeping track of one's calendar, maintaining local files of information, scheduling, controlling tickler files and a variety of other activities which consume valuable managerial time can be handled more easily and effectively by machine.

Computer conferencing is the ability to conduct an ongoing meeting with personnel in different geographic locations. An electronic message system is used to record communications among meeting participants. Each person involved in the meeting can access, read and respond to these communications, regardless of whether other participants are communicating simultaneously or not. The system thus provides a log of the meeting, and the asynchronous method of participation offers extraordinary flexibility, especially if meeting members travel frequently or are in different time zones. The technique has proven to be highly effective for managing the ongoing activities of large projects.

Teleconferencing is the ability to conduct meetings in a synchronous mode, where the participants are in different geographic locations. Here, the mediums used are video, audio or some combination of the two, operating over a network, and perhaps augmented by graphics transmission devices.

Teleconferencing reduces travel and speeds up communication and decision-making.

Experience with teleconferencing thus far shows that the technique reduces travel and speeds up information communication and decision-making. It is ideal for planning, progress reporting and general discussions where meeting participants know each other. Conversely, it is less effective in unstructured meetings, those where emotions play a role and those where one is attempting to sell an idea or a proposal.

The future office, then, is a world in which networks provide an array of capabilities to help managers and professionals do a better job. To reach that world requires not only a technology strategy but a strategy for organizing information to take advantage of machine capabilities. The extraordinary burden that will be placed on information specialists in developing those strategies are factors to be considered by senior management in the planning process.

Information Organization

If generalized access to machine-stored information is to be provided to managers and professionals over a network, the information must be organized to facilitate such access. Research is now underway in the information industry to determine how to meet that objective. To implement the information resource management concept, some knowledge of the principles of information organization are essential.

Systems are needed to manage information and the records in which information is stored.

Any time one imparts knowledge, a record is created. The record may be transitory, the brief recording of one's words in the brain of another, or more permanent when information is recorded on paper, on film, in the memory of a computer or in some other storage medium. As a result, the strategy for introducing the information resource management concept must consider not only the management of information but also the management of the records in which the information is stored.

When records have some characteristics in common, they are grouped in files. Since paper has been the most common medium for storing recorded information in an office, methods and procedures have been developed for organizing and controlling paper records in paper files. Those methods and procedures have been formalized in a discipline called records management. Over the years, a comprehensive body of knowledge has been

Several data base management systems have gained acceptance in the data-processing community.

developed by practitioners in records management governing the creation, use, storage and ultimate disposition of paper records.

When computers came on the scene, little or no thought was given to the idea that a magnetic storage medium might call for a different records management approach than paper. As a result, computer files were set up in exactly the same way as paper files in virtually every computer-based system developed throughout the 1960s.

The proliferation of machine-based files led to file control problems and excessive machine usage. Late in that decade, experimentation began with different approaches to file organization which led to the creation of a new discipline called data base management. It is a form of records management that attempts to organize the storage of information and files on a computer in a manner which makes optimal use of the characteristics of the storage medium used. A number of data base management systems have been developed, and they have gained strong acceptance in the data-processing community.

The approach taken to the storage of textual information in word processing followed the same route as data processing—it copied traditional paper systems. For example, paper correspondence is filed in cabinets according to some classification scheme designed to help find a particular piece of correspondence at a later date. Correspondence files on word processing magnetic disks have been set up in the same way.

However, machines can scan magnetically stored information and retrieve correspondence based on a name, a date, a particular combination of words or similar criteria. Elaborate prior classification is not necessary.

Thus, the idea of text management is emerging—the development of records management approaches to the storage of text which take advantage of the capabilities of the magnetic medium in which the text is stored. Ultimately, text management systems will join data base management systems as support elements in organizing machine-stored information to facilitate retrieval and use.

Records management principles were applied to microfilm images from the outset, in an ongoing effort to improve access to microfilmed records. The most modern of these is used in computer-aided retrieval. The closer we get to implementation of the network concept, the greater the pressure will be to ensure that those techniques integrate well with the records management systems for data and text. Ultimately, integrated records management systems will be required for records stored in the form of data, text, image and voice.

Information Specialists

The term information specialists is used to identify all office personnel who are involved in the acquisition, processing, movement and storage of information. Thus, people who are associated with information technologies—data processing, word processing, telecommunications, micrographics, reprographics and the like—are included in the term, plus administrative managers, records managers and others in information-related jobs.

Information specialists constitute a major reservoir of talent that senior management can call on in implementing the information resource management concept. They also provide management with some challenging problems for the future in terms of educational requirements, work overload, career concerns and orientation to the business.

Information specialists have problems of education, workload, career concerns and business orientation.

The burden of developing detailed plans for implementing the network concept will fall on information specialists. Further, the needs of every information technology will have to be factored into the plans. Thus, information specialists, who already have problems staying abreast of developments in one technology, will find themselves faced with the problem of learning about other technologies and how they interrelate. This need for broader technological education comes at a time when information specialists are already overworked and face growing demands for their services. The situation is compounded by the changes in information technologies which threaten existing organizational structures and alter anticipated career paths.

A second educational problem exists, one that is perhaps even more serious. Lack of senior management leadership in the establishment of performance objectives for office operations has caused office workers to embrace performance criteria which have little to do with business requirements.

Data-processing personnel pride themselves on their knowledge of their technology and their skill in applying it. In most cases, that pride is well-justified. However, if one were to quiz them about their knowledge of the business, the results would be less gratifying.

The operating philosophy which allowed data processing to separate itself from the rest of the office, and centralize itself in datacenters, effectively moved the function outside the mainstream of the business. In this vacuum, the interest and allegiance of the personnel involved quickly shifted from the business to the technology.

Technology must be looked on as a tool to help improve performance.

Word processing followed the same path. So have telecommunications, micrographics, reprographics and the other technologies. High levels of knowledge and proficiency have been achieved by personnel in these functions as an end unto itself rather than to accomplish a business objective. As new technologies come on the scene, one can anticipate that office personnel will react to them in similar fashion.

Thus, the reservoir of talent available to help implement the information resource management concept lacks an understanding of good business practices.

If productivity improvement efforts in the office are to succeed, this orientation must change. Technology must be looked on not as an end but as a means, a tool to help improve performance. A major educational effort is needed to convince information specialists that the objectives of the business rather than the characteristics of the technology are the bases for developing plans and assigning priorities.

In spite of these problems of education, workload and career concerns, information specialists are eager to get on with the job. Their trade journals are filled with articles about the office of the future, networks, the need to improve office productivity and information resource management. They are looking for leadership from senior management to provide a program to pursue these new developments.

The challenge to management is to make optimal use of the talents of information specialists in combining the information resource management concept into office productivity improvement programs.

Organizational Strategy

To be successful, office productivity improvement efforts must be organized as an ongoing, long-term activity. When one is trying to improve the productivity of managers and professionals, behavioral changes are needed, changes in the way people think about and handle their jobs. Such changes take time, and the productivity gains occur gradually.

If the information resource management concept is to be melded into the office productivity improvement effort and the whole process used to upgrade the management of office operations, then the same ongoing, long-term approach is needed.

Organizational units in place today should not necessarily be merged together. For the most part,

Organizational changes should be deferred until an operating strategy is developed.

they were organized around technologies rather than functional responsibilities. The fact that technologies are converging is not sufficient basis for organizational convergence. Rather, it is a signal that today's organizational strategy stems from a philosophy of technological separateness that is no longer valid. New organizational strategies should be based on business operating requirements rather than the idiosyncracies of information technologies.

Many proponents of information resource management see it leading to a new senior management position, the chief information officer. They argue that such a position exists to manage the people resource and the money resource, and similar treatment should be given to the information resource. A position along those lines may be created in the future by some companies, but speculation about it now is premature.

Information resource management is a concept, untested and unproven. It appears to have merit, but it does not have the strength to stand on its own. Melding it with office productivity improvement programs gives it an arena in which it can be examined and tested. However, if that effort is seen as an excuse for creating a new senior management position, it will probably founder in the morass of political infighting and power struggles.

The goal is to manage the office more effectively—people, machines, facilities and information.

A better approach is to defer organizational changes until an operating strategy is developed. The strategy should have several components. The first component is the recognition that the goal is to manage the office more effectively—the people, the machines, the facilities and the resource for which the office is most specifically responsible information. We are trying to make the office a more effective contributor to the success of the enterprise

The second component is education. Office personnel must be educated in the use of sophisticated management practices in office operations. Managers and professionals must learn about their roles in managing the information resource. Information specialists must know what is happening to information technologies. All must learn about those factors that will have an impact on office operations—the need to improve productivity, the explosion in information technologies, the changing nature of the office work force and similar developments.

The third component is converting the office from task orientation to goal orientation. Critical success factors must be identified, specific performance goals established, and performance measures developed.

The fourth component is the development of plans. One plan is needed to orchestrate the effort to introduce better business practices into the office. A second plan is needed to direct the productivity improvement effort, to establish a framework within which new approaches can be funded and tested, to incorporate productivity improvement into every facet of office operations and to institute appropriate reward systems. A third plan is needed to get managers and professionals directly involved in the process of managing the information resource to fit their specific needs. A fourth plan is needed to manage the introduction of the network concept and to maximize the potential offered by developments in information technologies.

Managers from many disciplines must participate in strategy development.

Analysis of this strategy indicates that representatives of a number of disciplines must participate in its development. Personnel managers must concern themselves with the educational requirements of the strategy. Corporate planning must participate in the development of goals for the office to ensure that those goals fit with business plans. Information specialists must participate in planning for the network. Overall, the strategy development effort must be led by senior management because the breadth of the activity, the number of disciplines involved and the ultimate impact on the bottom line demand that level of leadership.

Overall, the strategy development effort must be led by senior management.

Some companies may have in place a senior executive whose assigned organizational responsibilities encompass large portions of office operations; leadership of the strategy development effort might logically be vested in that individual. Ordinarily, however, responsibility for the management of office operations is fragmented and no one individual is the obvious choice to lead the effort. In that event, the strategy development effort should be carried out by an ad hoc task force led by a member of senior management who has been selected based on proven performance in improving the management effectiveness of operating units.

No one from the outside can specify what strategy a given company should follow to improve office productivity and implement the information resource management concept. Corporate culture, the degree of concern with rising office costs and unfulfilled information demands, current levels of management sophistication in office operations, the status of information technologies and the exigencies of the business environment are factors that will affect strategy content and the speed of implementation. Each of these can only be evaluated in the proper perspective from the inside.

However, there are three additional factors that should be incorporated in every strategy: the changing nature of the office work force; the cost of information; and information security.

The Office Work Force

The office is a people place and will continue to be, regardless of the inroads made by information technologies. The office will never be automated, in the full meaning of the word, nor is office automation a valid corporate objective. Routine office operations may be mechanized, but, beyond that, the value of information technologies lies in their ability to augment the intellectual capacities and capabilities of office personnel.

The changing nature of the office work force must be recognized in the strategy.

Given that fact, one must look at the office work force to see if it is willing to use the new tools being offered. Such an examination will reveal that the office work force is changing rapidly and has attitudes and aspirations that are different from its predecessors. The first difference is that the educational level of office personnel is rising. People who work in offices crave intellectual challenge and are openly critical of routine and drudgery. Since the capabilities of information technologies tend to support intellectual activities and minimize routine, the chances of their being used are very good.

Second, office personnel want to see the job through, to be responsible for an activity from its inception to its completion. They resist the old approach where activities were broken into components and responsibility was limited to completion of specific components. Today's office personnel want to see jobs through

People who work in offices crave intellectual challenge and are openly critical of routine and drudgery.

from beginning to end and be given wide latitude in determining how the job is to be done Here again, advanced information technologies support the pursuit of alternative courses of action

Third, the concept of participative management, of getting more people involved in the decision-making process, is gaining greater acceptance. So 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 Again, this greater sense of involvement is supported by the new tools offered by advanced information technologies.

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 more comfortable with machines, and that comfort level is flowing over into the office

Information Costs

Little consideration has been given in the past to the cost of acquiring information in the office and only slightly more to the true cost of processing, moving and storing information. If a manager or professional wants a piece of information, office personnel, with their orientation toward full service, will attempt to get the information and pay scant attention to the costs involved. In fact, the higher the rank of the individual making the request, the slimmer the chance that anyone will challenge the reasonableness of the inquiry versus the cost of providing an answer.

Information is unique in that it has no value in itself. Its value is determined by those who use it, and it can vary with time. Such is not the case with other corporate resources. People have intrinsic value Money's value and the value of materials and facilities are determined by the marketplace. But the value of information is in the minds of its users.

The cost of acquiring discretionary information must be justified in terms of job performance.

Information does have a cost, though, a substantial cost when one considers the number of people, the facilities and the machines devoted to handling information Some information in the office is required by the nature of the business or to meet regulatory requirements But much of it is discretionary and therefore subject to a test of its value versus cost.

Unfortunately, however, there are no mechanisms now in place to help establish the true cost of information, because information has never been looked at as a resource or even as a separate entity. Managers concerned about the number of paper files scattered throughout the office may institute records disposal programs. But the concern is much more about the physical space taken up by file cabinets than about the time people spend maintaining information in the files and retrieving it on demand.

Information stored on computers has been structured to produce regularly scheduled reports, and reasonable estimates can be developed as to what those reports cost. However, when someone asks for a special report, no valid technique is available to determine what it costs. Perhaps the best example of the lack of good management in the office is the inability to assign costs to the discretionary acquisition, processing, movement and storage of information.

Melding the information resource management concept into office productivity improvement programs offers an unparalleled opportunity to correct this problem. Part of the education of managers and professionals in their roles in managing the information resource should include the concept that information has a cost just like every other resource.

Incurring that cost must be justified by relating the value of the information obtained to the performance of one's job. Part of the education of information specialists should concentrate on the thesis that every machine use should have built into it the means of determining the true cost of that use Part of the role of senior management should be to ensure that discretionary information costs are justified according to a value system and a set of priorities that are in consonance with the business plan

In that way, the management practices developed in the line side of the business concerning discretionary cost justification are applied to the office in the management of the information resource

Security measures should control access to information and assure its authenticity, integrity and validity.

Information Security

As more and more information is transferred from paper to machines serious consideration must be given to information security. It is not that machine-based systems are less secure than paper systems. In themselves, they are probably more secure. However, they concentrate information in one place and facilitate access, authorized or not, to a vast store of information. The difficulty in finding information in paper files, which frustrates all of us, at least offers the consolation that those not entitled to the information will encounter the same difficulties. Not so with machine-based systems, however; if one can access the files, all the information in them is easily available.

As a result, systems which provide direct access to machine-stored information must have provisions built into them to prevent unauthorized access Fraud is one type of unauthorized access; invasion of privacy associated with access to personnel and other records is another.

There are a variety of ways to make machine-based systems secure Ultimately, however, security depends on people and their willingness to observe the security ground rules. A substantial portion of the education of managers and professionals about their roles in the management of the information resource should be concerned with information security.

Systems which provide direct access to machine-stored information must have provisions built into them to prevent unauthorized access.

The use of machine-based systems introduces additional security concerns besides unauthorized access—concerns about the authenticity, the integrity and the validity of the information retrieved from a machine-based system. For example, in an electronic mail system, letters are typed on a terminal and distributed electronically. When an addressee reads a letter on a screen, several security considerations arise, stemming from the ease of manipulating machine-stored information. The first is authenticity. Since the letter is not personally signed, did it actually come from the person to whom it is attributed? The second is integrity. Is the letter complete or were portions deleted from it? The third is validity. Were the contents of the letter changed in any way during transmission, storage and receipt? Control techniques are available to provide answers to all of these questions. The approach to managing information as a resource should include provisions that these techniques are built in to all machine-based systems.

We are presented, then, with an opportunity and a challenge. Effective management of the information resource will provide managers and professionals with the tools necessary to compete in the years ahead. Improving the productivity of the office will change that sector of the enterprise from a drain on the bottom line to a contributor to corporate success. Combining the two activities will facilitate introduction of proven management practices into office operations and assure that the future office will be managed.

In such an atmosphere, all those who work in offices will find themselves challenged to improve their performance and expand their potential. The organizational and operating constraints of the past will be minimized. Networks of technologies will provide an array of capabilities for broadening one's intellectual talents and operating skills. The goal will be to improve corporate performance and, at the same time, to foster personal growth. For it is in the expansion of our potential as human beings that all of our institutions will prosper.

Ultimately, better management of the office will improve corporate performance and expand human potential.

14

The Virtual Meeting

A Report on Computer Conferencing

By Clifford Barney
And Thomas B. Cross

Computer conferencing is widely regarded as a newfangled, mysterious substitute for a face-to-face meeting and in this respect suffers by comparison with video conferencing. This "horseless carriage" approach — calling something by what it's not — overlooks the most significant aspect of computer conferencing: this new medium is really not a substitute for anything.

Computer (tele)conferencing, sometimes called text or terminal conferencing, lets users conduct meetings with personnel in different geographic locations. An on-line memo system is used to record communications among meeting participants. Each conferee can access, read and respond to these communications, regardless of whether other participants are communicating simultaneously. The system also provides a transcript of the meeting.

The non-real-time method of participation offers extraordinary flexibility, especially if meeting members travel frequently or are in different time zones. The technique has proven to be highly effective for managing ongoing project activities and information exchange.

Computer conferencing uses the power of a CPU and communications network to support ongoing group interaction. Its most original contribution is its inherent ability to create a continuous record in machine-readable form. Participants in a computer conference always have access to complete documentation of their common project. And because the text is machine-readable, it may be searched by keyword, date or source and integrated with the individual user's private text files.

The second major aspect of computer conferencing, and the one that distinguishes it from all other forms of group activity, is that it operates in non-real-time, or asynchronously, doing away at a stroke with all of the administrative headaches associated with getting the attention of a large number of people at the same time. The flip side is also true: Everyone can have the floor at the same time.

Members of a computer conference are not normally on-line at the same time. They communicate indirectly, through the computer files that they jointly create. Meetings can now take place at any time and just about anywhere in the world. The host system software keeps track of who has seen what material through a status system.

The conference, then, is an ongoing affair, not a specifically allocated chunk of time. Its duration depends on the nature of the group task and the inclination of the participants. It is not tied to anyone's time schedule, and it allows members ample time to reflect on the issues.

Joint Access

What are the benefits of joint access to a text system? Basically, the network allows its nodes to share information. Text and data are made available widely (but controllably) and are susceptible to any of the software manipulations the user may care to employ.

The essence of information — as opposed to data — is that it has been evaluated by people for use in a particular situation or class of situations. It has been "humanized." Whereas data processing deals with numbers and values, computer conferencing deals primarily with text. It is therefore particularly suited for communications between humans.

"This communications tool is so powerful that it will soon come to dominate any system of which it becomes a part. It will change people's way of doing business," comments Jim Norton of Tymshare, Inc., who has been working with the firm's Augment system since its inception as a research project more than 15 years ago

How that change will come about is difficult to predict, since computer conferencing may be used in a wide variety of applications, but has yet to be adopted so widely as to permit easy generalizations. Because of the large amount of time executives spend in meetings (up to 80% or more of their working day), the most likely area for its use will be in supplementing face-to-face meetings. All one needs is a computer system with a sufficient number of terminals.

With computer conferencing, the meeting is not dependent on any one person's time schedule. A meeting can go on for long or short periods, controllable and facilitated by the conference manager who may, in fact, be located in another city. Most often, conventional meetings must be scheduled so far in advance that interest in them, as well as their ultimate impact, are lost. In one recent Satellite Business Systems (SBS) study, the average delay between the decision to have the meeting and the time of the meeting was found to be 47 days.

Even when the manager is down the hall, computer conferencing keeps people in touch. Assignments can be given and people can respond, argue or discuss work without having to go to a meeting. Conversely, there is ample time for reflection, which might not be available in a face-to-face meeting.

Unlike traditional correspondence, computer conferencing provides an ongoing electronic filing system for systematic and rapid retrieval: an electronic library at the user's fingertips. How many times have you lost something on your desk? Most computer conferencing systems are organized like "electronic desks" with places for memos, letters, messages, bulletin board and calendar.

Newspaper Systems

The closest approach to an industrywide application of computer conferencing may be the text editing systems now used by most newspapers. These are not normally thought of as conferencing systems, yet they bear many resemblances in that the text they handle is subject-specific and shareable by many users. Reporters create files that may be copied to other individuals or sent to general collections such as "sports" or "city desk" or "features." These files are managed and indexed by the software.

Newspaper text systems have provided users with great flexibility in creating, editing and printing stories. One of the most noticeable effects on newspaper operation has been the virtual elimination of the "back shop." Gone are the banks of linotype machines and the noisy composing rooms. Text now comes out of the editorial office in camera-ready form. The effect on the industry's economics has been deep.

But newspaper systems would have to be considered special cases of computer conferencing. What does the general form look like?

Applications Package

A computer conferencing system is a software applications package that permits a user group of any size to create, store and distribute text (in many cases, graphics and data as well).

"Creating" text means putting it into machine-readable form. That task may be performed either within the conferencing system or outside it. (Text editors on most conferencing systems are primitive; and in any case, off-line preparation of long text files saves on communications costs.) New text is kept in a temporary storage area until the user instructs the system as to its ultimate disposal. Normally, the options are to put the text into a private or memoranda file, a conference or a message file.

Specifically, computer conferencing is an interactive computer software system that generally allows for the following:

- Many-to-many communications with special areas for electronic meetings and discussions. These areas are accessed by people with approval of the conference manager, much like a normal meeting. Discussions cover various topics, specific interests and work activities. Calendar, scheduling and decision support systems can also be added.

- Personal notepad-memo and work areas. Each user has private files or scratchpads that are kept on-line for ease of use. Notes or memos can be sent either to other conferees or to a group conference.
- On-line bulletin board.
- Management and user reports and directories.
- On-line newsletters and journals.
- Status and tracking functions.
- Electronic mail/messaging, both one-on-one and broadcast communications.

However they are called, these options all implement more-or-less file processes. Private files and messages resemble their counterparts in word processing and electronic mail systems. It is the conferencing software — and the flexibility that permits material to be switched among the various subsystems — that makes conferencing so attractive as a medium for cooperative action.

A "conference" is a software subsystem that recognizes certain user accounts as privileged to read and write files. Typically, in an open conference, all members may read all items and contribute their own at will. They are not usually permitted to change files created by others, but this aspect is up to the system designer; all permutations are possible. It is frequently useful to give at least one member editorial power to add and delete text.

There may be many conferences within a system. Each may be open to anyone with a password into the system or may be restricted to a specific group. In either case, the software will keep track of who belongs to which conferences and, within each conference, will log who has seen which items. A user who logs in will be notified when there is new material present.

Within these general outlines, conferencing systems may take a variety of forms. Some, like Infomedia Corp.'s Notepad, are extremely simple and tightly controlled from the top. By contrast, the experimental Electronic Information Exchange System (EIES) offers a great variety of usage patterns. EIES is almost baroque in the multiplicity of its subsystems. Almost every type of communications pattern may be found somewhere on EIES, if the user knows where to look. Designer Murray Turoff has even constructed an electronic "marketplace" where members can advertise information and buy and sell it, with the EIES host recording the exchange of credits.

Designed for organizational hierarchies, Matrix from Cross Information Co. offers a range of management levels to fit corporate structures. (See product roundup beginning on In Depth/7 for more information).

Though computer conferencing software looks like any other applications program, its structure reflects its direct use by people signaling in natural language, where the conventions are implicit rather than explicit. There is a strong semantic component to the relation between subsystems. Conferencing systems make the learning process a lot easier by providing menus, maps to the logical network and on-line help to step the inexperienced user through the labyrinth.

The Virtual Meeting

Once understood, conferencing becomes a powerful tool. Conferences may contain text (and numbers) in any form. Content may range from items of general interest for a loose group of colleagues to the draft of a precise electrical specification. Because any item can be a mix of text and programs (a program is, in a sense, a particular kind of text), one item can call up other text items or other software.

By up- and downloading conference material to and from personal computers, the individual user can easily integrate private work with that of others. A software program called Mist, offered by New Era Technologies of Washington, D.C., allows personal computers to generate text and send it into computer conferencing systems.

This very flexibility makes the application of computer conferencing difficult to define. Computer conferencing is basically a network by which people with a joint purpose may conveniently carry it out. The goal may be the organization of a complex task or the creation of a jointly authored text. The SBS study found 64% of its subjects wanted increased communications with distant persons. Some examples of computer conferencing applications are described beginning on In Depth/14.

In general, computer conferencing is useful for both continuing and ad hoc projects. It is important to remember, however, that computer conferencing is not a substitute for face-to-face meetings, because it is spread over time. Where a face-to-face meeting or a teleconference might be called to integrate work done prior to the meeting or to assign future work, the computer conference is for work, discussion and consensus activity.

The medium has its limitations. However, the chief limitation, the lack of good graphics, is gradually disappearing. Some conferencing packages, such as Augment and Data Dynamics, Inc.'s Genie, do contain graphics software. Matrix is modular to the extent that it can interface other computer programs (graphics or otherwise) available on the mainframe. In other applications, users have valiantly tried to simulate graphics with alphanumeric characters.

However, there is no intrinsic reason that conferences cannot include graphics, financial modeling or any other computer activity. As the cost of graphics terminals declines, these programs will fit together as the user requirement grows.

Security is always an issue in systems used by large numbers of people. It takes on a quixotic aspect in the discussion of systems which are, after all, designed to disseminate information, not restrict it. There is a wide range of restrictions available for conferences, messages and personal "padlocks." Conferencing folklore is rich with tales of broken security codes, and in some circles, not to have penetrated the Defense Department's Advanced Research Projects Agency Network (Arpanet) is to lack a required "merit" badge.

Security breaches aside, system malfunctions can result in lost and misdirected data. EIES has a whole conference devoted to mishaps involving GTE Telenet, the packet network by which many members ac-

Advantages Of Computer Conferencing

- No time restrictions. No one is ever late for a meeting; no more telephone tag.
- No geographical restrictions. The system is always there.
- Lowest cost of teleconferencing technologies.
- Self-documenting and filing. The system serves as an electronic desk.
- No actors or performing skills required.
- Allows time for thought in work and management.
- Self-paced training.
- Users can participate in many conferences in a day. Waiting at the airport is eliminated.

cess the system. However, most mishaps are minor inconveniences.

Technical problems aside, user interaction is difficult to control on a network. This does not mean that secrecy is impossible; it depends on the network users, not the host. As yet, there are no software programs that censor. And restricting the allowed interaction of nodes obviously restricts the power of the network. One conferencing system became known as "Gripenet" after some of its members took issue with IBM policy on the VM operating system.

With much of the necessary equipment already in place, the main barriers to computer conferencing access are psychological. The user must read and probably write on the terminal. No one likes to write; it is a tedious and lonely task that reminds one at every step of one's imperfections. And pounding a terminal is seen by the managerial class, which could presumably benefit from the use of computer conferencing, as a task for underlings.

The absence of these prejudices in the newspaper publishing field, where writing is prized and typing ability is routine even among top editors, may be one reason that editing systems have become pervasive so quickly.

Of course, most groups would also have a number of "cyberphiles," those who become infatuated with the high-tech gizmos. Prof. Starr Roxanne Hiltz, a sociologist from the New Jersey Institute of Technology, surveyed 200 professionals using computers, many for the first time. She found that about 20% became so dependent on their terminals that when the computer didn't work, neither did the users. Most users now realize that computers do improve both quality and quantity of work.

A study of EIES usage by Hiltz showed the prime determinant of system use to be not typing ability, familiarity with computers or preference for speech over written communications, but *attitude*. The people who used the system most and professed to get the most out of it were those who anticipated that they would like using EIES before they ever came on-line. They proved to be the people who already knew other on-line participants and therefore already had some community of interest.

Specifically, computer conferees have found that such a communications system can:

- Reduce greatly the need for unnecessary travel, saving time and expense.
- Break the habit of meeting and encourage true dialogue to accomplish more in much less time.
- Allow issues to be dealt with when they arise, thereby increasing the speed, quality and effectiveness of decision-making.
- Improve the quality and quantity of consensus among project participants.

Since businesses are almost by definition communities of interest, the study indicates that the adaptation to written computer conferencing may not be so difficult as popular wisdom suggests. The quick acceptance of electronic mail systems supports this conclusion. Electronic mail is really a subset of computer conferencing.

In the future, computer conferencing will grow because of added capabilities, such as financial modeling, decision support systems and artificial intelligence. The same executives who have taken Visicalc to their hearts will find computer conferencing an elegant way of integrating their work with that of others.

Product Roundup

Augment

Strictly speaking, Augment is not a conferencing system; it is more extensive — a complete package for the joint processing of computer-generated text and graphics. Developed under Douglas Engelbart at the Stanford Research Institute in the 1960s, when it was known as NLS (for oN-Line System), Augment became the kernel of the worldwide Arpanet. Its structure is still used by thousands of Arpanet users who may have nothing to do with the commercial system now marketed by Tymshare, Inc.

The designer's intent was to build a system that would make a computer terminal into a tool to "augment" the human intellect much as the invention of writing did in providing a form for storing, retrieving and manipulating text. Tymshare markets the system as an "electronic briefcase" with which text can be written, edited, formatted, filed and distributed.

As one might suspect, this system is not simple. It is, in fact, anything but user-friendly, having no real conferencing front end, and requires much practice to operate with any kind of skill. Almost without exception, veteran users say that learning is worth the trouble. Properly used, Augment permits text to be manipulated almost at will, from creation to production of a finished document — printed, if the user wishes, in four colors.

Augment operates in a whole system of documents, at all stages from composition to final display, and may be used collaboratively. It is as a collaborative tool that Augment displays its real power, and that is why it belongs in a discussion of computer conferencing. However, where most conferencing systems are organized around communications requirements, Augment is based on text and who can use it. Rather than organizing text according to formal conferences, Augment permits various levels of file protection and user group definition that permit flexible methods of cooperative effort.

All files are kept in a vast seamless "journal" that may be accessed according to a user's predefined rights. Changes in text are logged by the system, which keeps several versions on file, noting who is responsible for each.

In its synchronous mode, Augment permits users to view as many as eight files simultaneously, passing control back and forth and "pointing" via a cursor to particular portions.

A messaging subsystem provides electronic mail service, and users are notified of new messages as they arrive.

Like newspaper editing systems, but unlike most general-purpose text editors, Augment recognizes text in logical elements, rather than as fragments of the particular text display system. That is, the system sees sentences or paragraphs, not "lines." Each text element is related to the others according to a user-assigned level: for example, the topic sentence of each paragraph may be on one level and the rest of the paragraph on a lower level. In turn, the paragraphs may be related to higher-level sections.

In all, Augment recognizes six different levels of text. By choosing to view only certain levels, the user may therefore review text through "filters" that are as coarse or fine as the situation requires. A user can scan text and "zoom in" for more detailed information at will.

Augment includes a calculator, a sort function, graphics (with a Tektronix, Inc. 4014-type terminal) and various print functions. It may also be used to create forms.

Accessed via Tymnet, Augment may be used with any Ascii terminal, but for fullest use of the system, Tymshare recommends its own terminal, which has been modified to accept directions from two I/O tools that supplement the normal keyboard. One is a "mouse" that permits the user to move the cursor around the screen quickly in any direction, without the awkward time-consuming arrow keys required by most systems. The mouse is a small device that rolls around a table top and generates error voltages that the terminal turns into X-Y coordinates on the screen.

The other device is a five-key chord set, similar to a court reporter's stenotype machine, that enters characters through binary code. Pressed two at a time, the keys allow the entry of 31 different Ascii characters. (The "zero" entry, being no keys at all, cannot generate a character.) With a shift and supershift button on the mouse, the total number of characters is increased to 93. Skilled users operate the chord-and-mouse set to enter commands, reserving the keyboard for entry of long strings of text.

Tymshare markets Augment to Fortune 1000 companies, government agencies and "anyone who wants to augment professional activity." The system is specifically targeted at professional information workers; it is not a secretarial tool. The cost is based on Tymnet access charges and averages $14 to $18/hour, depending on how the buyer uses the system. The special terminal may be leased from Tymshare at $200/mo. Tymshare will also sell the software for installation on a user's host (a Digital Equipment Corp. system running Tops-20).

Tymshare is at 20705 Valley Green Drive, Cupertino, Calif. 95014; (408) 446-6000.

Notepad

Designed by Dr. Jacques Vallee, one of the pioneers in conferencing research, Notepad provides messaging, both synchronous and asynchronous conferencing, keyword searching and graphics. Yet, beginners can learn all essential features in a matter of hours.

The key is in Notepad's menu structure, which turns a keyboard's numeric pad into a set of function keys. Any menu system performs this trick, but Notepad makes it obvious. Users are provided with a color-coded function card that fits over the number keys. In command mode, these keys become entry points into Notepad's various subsystems.

The systems are partitioned so that the user may write or read private messages, choose a conference, write or read conference items, edit or otherwise manipulate text files. The user may access special Notepad features such as graphics, communications from an off-line word processor or on-line help.

Within the subsystems, additional menus list further user options. A carriage return takes the user back to the original command mode to switch to another subsystem. Notepad's text editor is rudimentary, being line-oriented rather than screen-oriented, but this drawback is mitigated by the system's easy method of accepting text that has been prepared and edited off-line.

Notepad is operated by Infomedia Corp., a company headed by Vallee. Most Infomedia clients access Notepad via Tymnet at up to 1,200 bit/sec and use the software resident on the host at the company's San Bruno, Calif., headquarters. Infomedia charges a $1,000 startup fee and then $60/hour, plus $7/hour for Tymnet. Discounts are available for long-term commitments. Within an account, a user may establish as many projects as required and within each project as many conferences (called "activities") as required.

To set up these projects and activities, Infomedia first consults with the user as to what specific applications are contemplated. Infomedia will train customers in the use of Notepad, and subsequently an Infomedia representative takes part in one of a customer's conferences to provide on-line assistance. (The customer still may maintain private conferences to which Infomedia does not have access. The charge for this assistance is limited to the actual connect costs for the Infomedia representative, $1/min).

Users have free use of 100 pages (approximately 2,500 characters per page) per month and pay $1/page/mo thereafter.

The system's principal use, Infomedia says, is for project management and for ongoing information exchange.

About 30 large organizations now use Notepad, including Bechtel Power Corp., Cities Service Co., Nasa's Ames Research Center and the Electric Power Research Institute. The Nuclear Safety Analysis Center in Palo Alto, Calif., installed Notepad to link all U.S. nuclear power plants following the Three Mile Island accident in 1979.

Infomedia will also sell the entire Notepad package, which will run on any DEC computer supporting the Tops-20 operating system. The price is $50,000. The company reportedly has tentative plans to introduce a version for IBM's VM/SP operating system.

Infomedia is at Suite 275, 801 Treaser Ave., San Bruno, Calif. 94066; (415) 952-4487.

Genie

A conferencing system called Genie (for GENeral Information Environment) is being marketed specifically for scientific and engineering applications by Data Dynamics, Inc. of Portland, Ore.

Designer Steve Heitman calls Genie a "value-added data base management system" that integrates text and data.

Genie incorporates communications, word and graphics processing, calendar and scheduling functions and a "personal information management" system. Its heart is a relational data base in which users may read and write. Conferences are called "repositories" and are organized by an administrator who has general editing functions. The system has screen-oriented word processing.

The full text of Genie files is searchable, though Data Dynamics also plans to add a bulletin-board function with a controlled vocabulary, which may be searched by keywords (a less sophisticated, but faster, process).

Genie has been in use for three years, during its development, by more than 300 users at a large Portland-area electronics company. The system, written in Pascal, operates on the Control Data Corp. Cyber 175. However, it is portable, according to Heitman, and will run on the Unix operating system. It requires 256K bytes of main memory.

Data Dynamics sells the mainframe version for $65,000 and the smaller version, designed for a DEC VAX-11/780, for $35,000. The reason for the price differential, Heitman says, is that the VAX version will support fewer users. New users may test the system on a Data Dynamics host for $5,000/mo over a three-month period.

The scientific/engineering market is not as large as the business market, Heitman concedes — but, he says, its members are higher on the learning curve and more likely to be capable of using sophisticated systems.

Genie offers sophisticated directory management and multiple user interfaces. It has a "help" system that may be tailored to a user's level of expertise. It is compatible with X.25, Decnet and Hyperchannel communications protocols, as well as telephone packet-switched nets. Its communications software supports the routing of memos and questionnaire functions as well as electronic mail and conferencing.

Data Dynamics can be reached through Box 5517, Portland, Ore. 97228; (503) 286-3174.

EIES

The Electronic Information Exchange System (EIES) network, operated by the New Jersey Institute of Technology under the direction of Prof. Murray Turoff, can provide a convenient test bed for companies wishing to experiment with computer conferencing.

Turoff, with EIES cofounder Starr Roxanne Hiltz, wrote *The Network Nation* (Addison-Wesley, 1978) and is one of the most knowledgeable experts on computer conferencing's capabilities and potentials. EIES has a large population of on-line sociologists and computer scientists who have studied the system extensively; their reports are available on-line. Users are occasionally asked to participate in such studies, though compliance is voluntary and confidentiality is promised.

EIES offers so many conferencing features that beginners may feel overwhelmed. Yet, the system works perfectly well with a small subset of these features, and new users quickly learn to find their way around.

They are helped by a set of tree-structured menus and the on-line presence of a "user consultant" — an experienced EIES user who will provide a quick response to queries. There is normally at least one user consultant on-line at all times, and a system monitor is always available for help.

Equally useful to companies evaluating computer conferencing as an operational mode is the system's elaborate monitoring software. EIES tracks user activity meticulously. Members always have available to them on-line, monthly and cumulative totals of time on-line and messages and conference items composed and read.

Since EIES supports a variety of usage patterns (simple messaging, conferencing, private and group notebooks and so on), companies may experiment and then track usage to see which approach offers the best trade-off between costs and user acceptance.

More so than most conferencing systems, EIES is a true community, with an on-line newsletter to alert members to activities on the system that may be of interest to them. Nevertheless, EIES welcomes corporate users, and their conferences may be totally private. Under some circumstances, companies may even protect their members from receiving messages from outsiders.

A private "conference" on EIES is simply a set of files accessible only by specific users. Access is provided by a moderator, who has wide freedom to add and delete members and to modify text. The files themselves are numbered consecutively, dated and given keywords; they may be associated with another file if the user wishes. They are normally signed automatically by the system, but may also be displayed anonymously or under a pseudonym. (Messages may be addressed to pen names.)

Any of these tags may be used to search for a particular file. To save time, many conference moderators maintain an index of comments in a separate file.

Users write text into EIES in temporary "scratchpad" files. Once the material is in satisfactory form, it may then be stored in the appropriate notebooks or conferences or sent as a message.

The mechanisms for performing these electronic manipulations are tailored to the user's level of sophistication. Neophytes are stepped through a series of menus. Once they gain some familiarity with the system, they may suppress the menus and merely type in answers to system prompts. The next step is to "answer ahead" with a whole string of commands that anticipate the prompts. Experts can create their own macro commands for frequently used functions from the EIES programming language, Interact. A fifth command level permits the user to bypass the system's tree structure and move directly from one subsystem to another.

EIES keeps track of who has seen what text. Messages are automatically acknowledged so that a sender always knows when a message has been received. (Recipients need not accept messages, but they will be offered them automatically at each log-on until they do.) A "marker" is kept for each member of a conference, so authors can check to see who has or has not seen a given comment. Users can, however, reset their own markers in order to bypass comments if they get too far behind.

EIES is accessed via the Telenet or Uninet packet-switched networks or by direct dial to its Newark, N.J., headquarters. It offers a variety of pricing structures; the basic Class 1 account costs $75/mo, with users being billed for Telenet ($9/hour as of July 1) or Uninet ($7/hour) charges. EIES headquarters is located at 323 High St., Newark, N.J. 07102; (201) 645-5503.

MTX (Matrix Transaction Exchange)

Matrix is a second-generation conferencing system created by Cross Information Co. It resulted from research into management information network development.

Matrix features include unlimited conferencing, discussion and user memo "yellow pad" capability, management reports, mail/bulletin board, on-line "help," low memory requirement, a multiuser environment and complete system management via menus (tree-structured).

Matrix's innovation lies in the administration over the entire system. With menu-driven functions for the Matrix system operator, conference manager and discussion leader and user functions, the system was designed for management control in corporate organizations. Each of these functions allows certain privileges for conference management and administrative activities as well as extensive report generation. Each of these functions is accomplished through use of only the number keys. Managers can work with and manage Matrix without typing skills.

A directory function provides a range of information on such topics as conferences, discussions, memos, leaders, managers and messages. With on-line "help," instructions and training conferences, rapid learning is possible.

A meeting status indicator lets each person know where the meeting is and what has occurred and even go back to the very first meeting, if necessary. At any point in the meeting, the user can review everything that has already transpired. In addition, he can go back to the very first meeting or any one in between for reference.

Matrix supports a range of communications from small project groups or large multinational organizations. The package can be integrated with other applications software residing on the computer system.

Conferences can be arranged for small to extremely large groups. In addition, conferences can be arranged for individuals, which provides for an unlimited "electronic file cabinet." The package features user-determined keywords as well as open searching. Increasingly, organizations are extended over long distances throughout the world. Parts are collected from the four corners of the world, assembled and shipped internationally.

Matrix was designed to be used in these emerging multinational operations.

Matrix recently won the Outstanding Information Technology Award from the Associated Information Managers of Washington, D.C.

Matrix prices start at $1,000 for monthly lease installed in-house for DEC systems. Matrix is also available as a modular system designed to interface with other existing computer programs.

Cross Information Co. also provides Matrix on a time-sharing communications service for $25 per hour including GTE Telenet charges and a $50 one-time membership fee.

Cross Information Co. is located at Suite B, 934 Pearl Mall, Boulder, Colo. 80302; (303) 499-8888.

Conferencing In Action

The organizing committee for last spring's Office Automation show in San Francisco used Infomedia's Notepad system to integrate the task of putting the show together. The giant Bechtel Corp. also uses Notepad on a dozen construction projects, and more than 600 Procter and Gamble engineers use the Confer system to coordinate their work.

Among other conferencing users, the Joint Electron Device Engineering Councils of the IEEE have used the EIES network to develop hardware and software standards for solid-state devices. Tymshare operates a huge conferencing network, called VNET, for IBM. Einar Stefferud, a Huntington Beach, Calif., office automation expert, works with his defense department clients over the Arpanet.

The following are some case studies of how computer conferencing may be used in both large and small applications.

Nuclear Notepad

One direct result of the nuclear accident at Three Mile Island in 1979 has been the linking of every nuclear power plant in the U.S. and many abroad by a computer conferencing system.

The special commission that investigated Three Mile Island, under the direction of then Dartmouth College President John Kemeny — known previously as the guiding spirit behind the Basic programming language — recommended that the nuclear power industry form an international committee for the exchange of information on plant operation.

The industry chipped in to fund and staff the Institute of Nuclear Power Operators. The institute, based in Atlanta, decided to coordinate its operations via the Notepad conferencing system.

There are now 400 individuals from 100 organizations taking part in every one of the 65 U.S. utility companies licensed to build or operate nuclear plants, plus four vendors of reactor cores; eight architectural/engineering firms that design plants; and utilities organizations in Canada, Mexico, Taiwan, Japan, Spain, France, Sweden, Germany and Italy. Utilities in Brazil and Korea will soon join.

Notepad was chosen as the conferencing medium because it was one of the few such systems available at the time, according to Ron Simard of the institute's communications section. It was already in use by the Electric Power Research Institute, some of whose members are also in the nuclear group. It also had the benefit of being easy for unskilled personnel to use.

At any given time, the institute coordinates 20 to 25 separate conferences on various aspects of nuclear plant operation. One, for instance, focuses on licensing activities of plants under construction. Another concerns radiological information bearing on health problems. One conference exists for the reporting of what the industry calls "unusual events" bearing on safety. For example, if engineers at one plant find that leaving a certain valve open leads to a potentially dangerous situation, they can alert others to the problem. The valve failure that crashed Three Mile Island had already occurred, with less serious results, in a Toledo plant.

There is one "hotline conference" that deals with emergencies. It has been used only once.

The conference users come from both top and middle management, according to Simard. At nuclear power plants, the users are the plant managers, who normally delegate the task to secretaries. Users at corporate headquarters tend to be mid-level engineers, who go on-line in person. Direct participants are more active conference members, Simard says.

In general, usage reflects individual corporate philosophy. One Midwestern utility, for instance, keeps all conferencing activity centered at corporate headquarters and funnels information and queries to its plants by regular company channels. Other companies allow complete freedom of access.

Simard says the system is strongest in bringing about the widespread, timely dissemination of information and in making that information easily retrievable by members (through Notepad's search procedures). It is weakest, he says, in eliciting answers to specific queries.

Even so, he adds, most members log on at least once daily, and users have the benefit of knowing that requests for help will be seen immediately by the entire worldwide membership.

Writing by Committee

Preparing a document from the contributions of a number of widely scattered individuals is an exercise in logistics in which the most important variable — the availability of the participants — cannot be controlled. Faced with this problem, Joseph P. Martino of the University of Dayton stitched together a conferencing system from available computer software and turned out in three weeks a contract proposal that otherwise, he says, would have taken months to write.

Computer conferencing was a natural medium for Martino since the proposal itself concerned support for an experiment with computer conferencing in higher education. The experiment was designed by the university's computer science department, carried out by the engineering department, evaluated in the School of Education and sociology department and managed by Martino's research department.

"I knew I would never get the 11 people involved together in the same room at once, let alone regularly," Martino says. Therefore, he decided to use the electronic mail system on the university's VAX computer.

Martino put an outline of the proposal into a VAX file, then messaged questions about it to the various departments.

Using the replies, he began writing drafts of the sections, incorporating the material sent in response to his messages.

The others then commented on the drafts in separate files. Succeeding versions were also stored on-line and dated so that different versions could be compared.

"The proposal was really a joint effort," Martino says. "Everyone on the team made significant contributions and interacted with everyone else. It wasn't as though we asked each person to write a portion of the proposal, then simply pasted the independently written pieces together. We had the kind of objections, suggestions, revisions and so on that would have taken place in a more conventional committee.

"The striking aspect of the activity is that we got it done so quickly. Each member was able to take part on his own schedule. For all practical purposes, we conducted a continuous, month-long committee meeting," Martino remarked.

Martino notes that he went into the experiment expecting it to work well and that the other members were highly motivated to complete the project.

"Computer conferencing cannot substitute for motivation, but it can provide a convenient means for collaboration among people who would otherwise find it difficult to meet to carry out joint activity," Martino says.

Teaching on the Network

A two-year course in advanced management concepts may sound like an expensive luxury to executives who cannot justify spending so much time away from their jobs, however promising the benefits. But as taught by the Western Behavioral Sciences Institute (WBSI) in La Jolla, Calif., the course entails a minimum of work time, since it is conducted as a computer conference.

Equipped with terminals and accounts on the EIES conferencing system, members of the course take part at times and places of their own choosing. They take part in group discussions and decision games and query both the faculty and each other. There is no need for note-taking, since all material presented is always available to any member.

The course started last January. The members, almost all of them hunt-and-peck typists, spend an average of 13 hours a month on-line, and there have been no dropouts, according to Darrell Icenogle, the institute's director of educational resources.

The course began with an eight-day training session at La Jolla. The content and purpose of the course — which stresses interpretive management processes and the role of value systems — were established, and the members were trained in the use of EIES.

Then, armed with a simplified version of the EIES documentation compiled by Icenogle, the executives returned to their desks and began their asynchronous participation in the course.

The beauty of the program is that it uses the time executives have available, according to WBSI President Richard Farson.

The course is heavily moderated by WBSI faculty, a factor that Icenogle says is critical to its acceptance. Members responded favorably when the moderator took the time and trouble to index and summarize conference items; some even began making their own summaries of group discussions and offering them for inspection.

The result, Icenogle says, is that the conference developed a kind of "weaving" of the members' ideas that adds a new dimension to what would otherwise be a simple exchange of texts.

One spinoff from the course takes advantage of one of computer conferencing's major benefits: the creation of a continuous record in machine-readable form. This text may be edited and then printed for distribution to people not involved in the electronic conference. WBSI is editing the content of its management course into a textbook for wider distribution.

About the Authors

Clifford Barney is a journalist based in Berkeley, Calif., who covers computers and communications. He has written extensively about electronics in the trade press and is currently working on a book about computer information networks, which will be published next year by McGraw-Hill.

Thomas B. Cross is president of Cross Information Co. of Boulder, Colo. He teaches courses on office information systems at the University of Colorado and at Regis College and is writing a book on teleconferencing for Prentice-Hall. A corporate director who advises companies in high-growth areas, he developed the Matrix computer conferencing system.

The Cost Picture

Computer conferencing software comes in a variety of packages at a variety of prices and pricing methods. EIES costs rise steeply with each user added, for example, while in other systems the cost per user will decline with each new member. Some typical prices are included with the system descriptions that begin on In Depth/7.

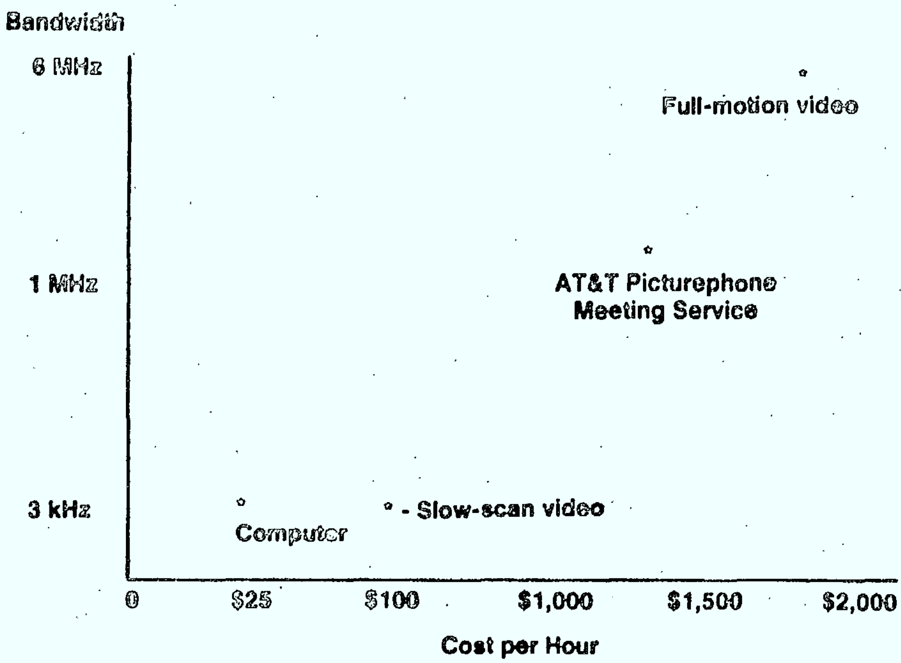
Beyond the cost of the software itself, communications charges obviously account for a large chunk of conferencing costs. One determinant of communications costs is channel bandwidth when comparing computer conferencing to video or audio conferencing. Computer conferencing systems will operate over normal telephone lines at 4 kHz, whereas full-motion video conferencing, for instance, needs 6 MHz (see figure below).

The labor cost of using various channels of communications may also be considered. The cost of an average business letter is now $7.11, up 7.2% over the 1981 cost, according to a survey conducted by the Dartnell Institute of Business Research, Chicago. The price of $14.22 per ounce for a business letter makes such correspondence more valuable than silver in today's market. By the same standards, a message sent electronically costs about $1. The key difference is that unproductive labor, paper costs and sender's time have been reduced substantially.

Another study has calculated the cost of each successful telephone call to be $12.92. And U.S. companies now spend $21 billion yearly for travel; one research firm states that 15% of that figure, more than $3 billion, could be saved by the use of telecommunications and teleconferencing.

In short, computer conferencing costs the price of a terminal ($500-plus), a communications modem ($100-plus) and an account with one of the companies that provides such a service, which starts at $50 one-time and $25 per hour but ranges higher depending on the company. Prices for an in-house system start at around $15,000, or $1,000 per month on a rental.

For some companies, conferencing can make sense as a way to get more mileage out of hardware that is already in place, such as terminals, computers, processors and communications equipment.



The Impact of Office Automation on the Organization: Some Implications for Research and Practice

Margrethe H. Olson and Henry C. Lucas Jr.
New York University

Computer technology has recently been applied to the automation of office tasks and procedures. Much of the technology is aimed not at improving the efficiency of current office procedures, but at altering the nature of office work altogether. The development of automated office systems raises a number of issues for the organization. How will this technology be received by organization members? How will it affect the definition of traditional office work? What will be its impact on individuals, work groups, and the structure of the organization? This paper presents a descriptive model and propositions concerning the potential impacts of office automation on the organization and it stresses the need, when implementing automated office systems, to take a broad perspective of their potential positive and negative effects on the organization. The need for further research examining the potential effects of office automation is emphasized.

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General Terms: Experimentation, Management, Theory, Human Factors

Additional Key Words and Phrases: office automation, automated office systems, impact on organizations, electronic mail

Authors' Present Address: Margreth H. Olson and Henry C. Lucas, Jr., Computer Applications and Information Systems Area, Graduate School of Business, 100 Trinity Place, New York, New York 10006.

Introduction

The term "office automation" is generally considered to refer to the use of integrated computer and communications systems to support administrative procedures in an office environment. Automated office systems represent structured methods of handling business text processing and communications through an integrated network that may include word processing for generating correspondence, electronic message systems for person-to-person communication, teleconferencing services, facsimile transmission, electronic filing systems, on-line calendar systems, and links to corporate files and outside services [6, 39]. In the automated office, not only will office work be performed more efficiently, but the concept of office work itself will be altered [9, 19, 39, 44, 49]. The greatest potential of office automation is not expected to be from the improvement of clerical and administrative tasks, but from the ability of managers to gain increased control over their operations [9, 39].

Two major factors motivate business organizations to consider automated office systems. The first is a critical need to improve the productivity of both clerical and managerial office employees. While office costs have doubled in the last ten years, office productivity has risen only four percent [48]. The size of the office work force is expected to double between 1975 and 1985 [51]. It has been estimated that up to 95 percent of a manager's time is spent in written and verbal communication [40], much of which could be affected by office automation.

The second reason for interest in office automation is the increasing complexity of organizational decision-making and information needs. The more traditional forms of communication such as telephone, mail, and person-to-person meetings may be ineffective for processing large volumes of information rapidly. In the future, this technology may be the only feasible way to deal with information processing in increasingly complex and rapidly changing organizational environments.

Components of Automated Office Systems

A broad definition of office automation may include all use of computer technology to support the "knowledge worker" [39, 51]; this definition includes computer-aided graphics and design tools, decision support systems, and any use of personal computers for work-related tasks. In this paper a more narrow view of office automation has been taken, concentrating on the administrative component of an organization's functioning. We are concerned with the collection and dissemination of information that prior to office automation was not supported by the organization's formal computer-based information systems [17]. A critical component of automated office systems under this focus is their communication functions; it has been suggested that communications technology is the most significant factor in redesign of organizations through office automation [30]. The other major components to be considered here are text processing functions and personal applications supporting the administrative responsibilities of office workers.

In the restricted definition, automated office systems are generally based on interactive workstations connected to a communications network. The workstations have intelligence and storage capabilities managed either through a central computer or distributed to the workstation themselves. Workstation functions may be tailored to different roles, e.g., managerial, professional, secretarial, or even to individuals. Each workstation would have some degree of functionality of three components: communications, text processing, and personal applications.

Text processing capabilities of automated office systems are in common use today. The features that prepare, edit, and store text will in the future be augmented by the ability to file documents electronically with cross-reference indexes and keyword searching. Equipment for automatic facsimile transmission and automatic phototypesetting is also available.

Aids for interpersonal communication include any facilities for distribution of correspondence to an electronic "mailbox" of the recipient. The most common form of interpersonal communication is "electronic mail," where a user types a message at a workstation or computer terminal that sends it automatically to the mailbox. Upon transmission the message is immediately available to recipients. Store-and-forward message systems based on audio recording are also available. The significant feature of electronic mail and its audio counterparts is the asynchronous nature of communication. Both sender and recipient control the timing of their portion of the communication, thus eliminating the inefficiency of incomplete calls and minimizing the need for interruptions.

Personal applications include the capability for streamlining individual administrative tasks and are used by individuals at their own discretion. Examples of personal applications are on-line calendar and scheduling programs which can be used to keep a record of an individual's schedule and, if feasible, compare schedules of multiple individuals in order to select meeting times. Reminder systems can be used for follow-up on previous messages, for reminders of appointments based on the automatic calendar, and for tracking project schedules. Personal contacts may be electronically filed with multiple reference indexes for retrieval in order to generate personal correspondence or obtain such information as telephone numbers.

An important feature of automated office systems under this definition is easy accessibility. At a minimum, terminals or other access facilities should be readily available to "principals" (primarily, managers and professionals) and support staff. With the decreasing cost of electronic equipment, centralized office support facilities, which were motivated by economies of scale for equipment, should give way to an acceptance of the need for convenient access.

Automated Office Systems in the Organization

While the potential for office automation to improve office productivity appears compelling, such improvements will not accrue automatically. What is the appropriate strategy for implementing such systems? Designers emphasize clear objectives, proper planning, choosing an appropriate site for a prototype, eliciting the support and involvement of affected parties, etc. [7, 9].

Given that automated office systems are successfully implemented in the organization, are productivity improvements assured? Even more important, *how* will the new systems affect patterns of work, individual and group interactions, and organizational structure? How will the organization of the future look given the new technology?

Although there have been a number of major evaluations of the effects of automated office systems on office activities and communication patterns [8, 13, 16, 18, 27, 33, 42], little attention has been paid to its long-term effects on organizational functioning. The purpose of this paper is to consider some potential long-term organizational implications of office automation in order to (1) call attention to the need for research to increase our understanding of the potential effects of the technology and (2) alert practitioners to take a broad perspective when implementing these systems.

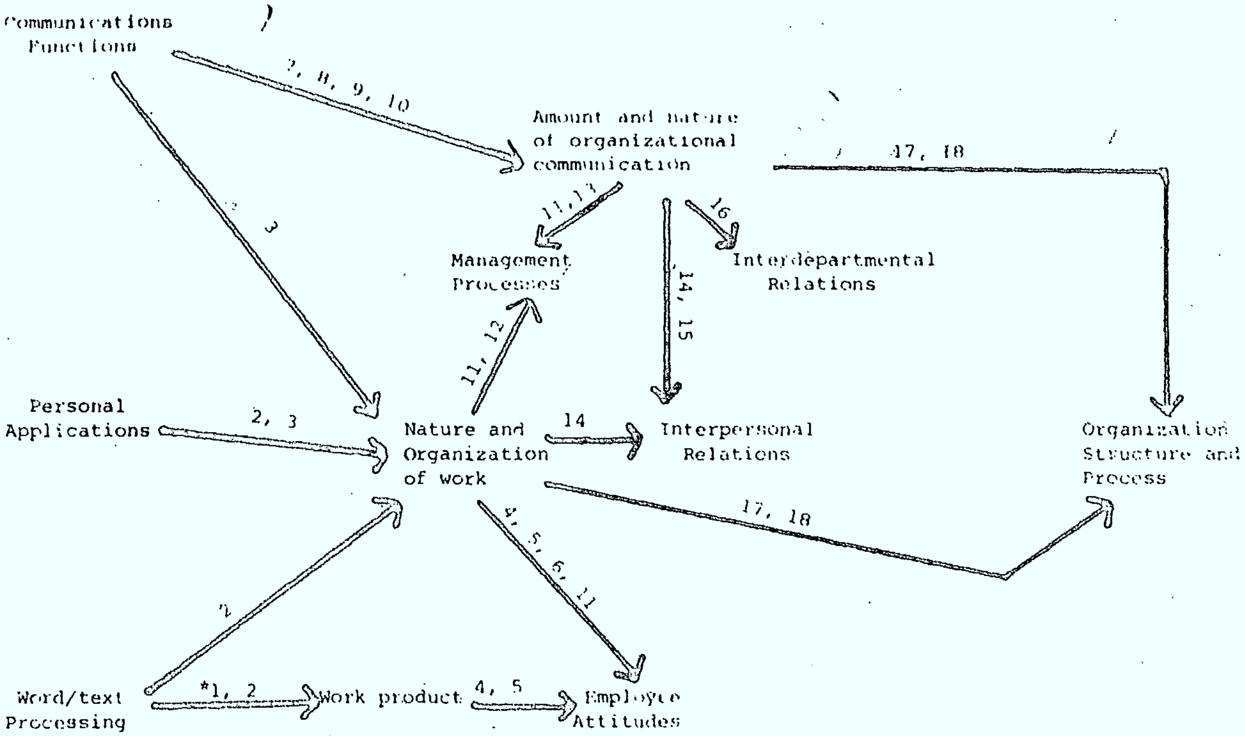
Some possible effects of office automation components on the organization and its members are illustrated in Fig. 1. The figure represents organizational characteristics affected by the successful implementation and integration of system components. The figure suggests that employee attitudes, management processes, interpersonal relations, interdepartmental relations, and organizational structure will be altered by automated office systems through intervening changes in the locational and temporal definition of work, shifts in the mode and timing of communication, and changes in the work product itself.

The descriptive model in Fig. 1 assumes that a certain level of system implementation and utilization has been achieved. The level of maturity of an automated office system may be considered to be a function of

— the number of individuals with access to the system
— the number of organizational subgroups connected to the network
— the percentage of work accomplished through the system

A large number of individuals need to utilize the communications component of the system before the system will affect organizational communications pat-

Fig. 1. The Impact of Office Automation



* The numbers refer to propositions in the text.

terns [20, 49]. For instance, if one member of the target group of a communication does not have access to the system, other procedures need to be instituted to accommodate the exception. This reduces the overall effectiveness of communications substantially.

An organizationally mature system is utilized across major organizational subgroups. For instance, the authors utilize an electronic mail system in a university for intradepartmental communications only. Although it is used extensively, under this definition it will not be a "mature" system until it is implemented in other academic departments and the Dean's Office. In general, several subgroups that are central to the organization's major workflow need to utilize the system before this criterion is met.

The third determinant of system maturity is a minimum percentage of use by each organizational member on the system. Although an arbitrary definition in terms of time spent at a workstation, etc. is not very helpful, casual use for an occasional inquiry or demonstration clearly does not meet the criterion. Instead, it is assumed that after a period of utilization an individual will become more dependent on the automated office system. If access to the system is denied, the individual would be seriously hampered in performing his or her duties.

The descriptive model shows classes of interacting effects of mature automated office systems. Although research to date has focused on the individual productivity of secretaries and clerical workers [4, 18, 53], little has been said about potential changes in role definitions or in quality of work life. Impacts on managerial workers are more difficult to determine, primarily because the work a manager does is itself not well understood. Changes in communications may affect both the formal aspects of intragroup relations (such as managerial span of control) and informal social interaction among individuals. The locational and temporal definition of work may be altered, requiring that managers monitor and control employees remotely. Enhanced availability of communications paths across departmental boundaries may have significant impacts on interdepartmental relations. Ultimately, the goal of any intraorganizational change or intervention is improved organizational effectiveness; increased organizational flexibility in structure and processes are expected to contribute to this goal.

This paper assumes what can best be termed a "socio-technical" perspective of organizations, that is, social and technical-economic elements of the organization as a system interact to produce outcomes such as those predicted here. It is more representative of the views of "structural" and "human relations" perspectives of organizations, as described in [32], than a "class politics" view. A word should be said, however, about this latter perspective. The political view assumes that automation (in this case, of the office) implies a division of labor that leads to decreases in skill, knowledge, and worker control over activities [32, 54]. In this view, "The question for management is ... not simply one of saving money through reducing the payroll, but clearly one of securing the maximum control over the labour process in pursuit of maximum profitability" [15, p. 286].

The political view is not totally ignored. We recognize that the way in which an automated office system is implemented may lead to such outcomes; however, automation itself does not *necessarily* reduce individual skills or control over work. The socio-technical perspective assumes that the tools of automation are neutral; the social, task, and structural factors combine with technical factors to influence the nature of the work activity.

Some Research Propositions

The descriptive model suggests numerous propositions regarding impacts of mature automated office systems on the organization. In this section some specific research propositions are discussed. Where research in other disciplines can be applied, the implications for predicting the impacts of automated office systems are discussed. The propositions are stated in very general terms; the goal is to suggest important issues that need to be investigated further. The underlying premise is that behavioral and organizational implications of these systems are not well understood. Research that examines the propositions presented here will greatly enhance our understanding of those critical factors that will help automated office systems improve organizational productivity and effectiveness.

The discussion of the research propositions also emphasizes that potential effects are often complex, with both positive and negative connotations. Where possible, the discussion includes some speculation on design strategies that encourage positive organizational changes and minimize negative impacts.

Effects of Office Automation on the Nature of Work

It has already been pointed out that office automation is expected to increase organizational productivity through redefinition of office work rather than increased efficiency of current office functions. Several potential changes in the nature of work are proposed.

Proposition 1: Automated office systems, especially text processing functions, can improve the quality of written documents produced (e.g., *reports*).

A number of specific office activities can be "streamlined" through automation even without a major reorganization of office functions. Activities associated with the preparation of correspondence addressing, copying, formatting, distributing, etc. can be handled more efficiently, especially if word processing is integrated into a communications network. The resultant output should also be attractive physically. In addition, the number of media transformations required to compose and distribute correspondence will be reduced [5]. Media transformations occur between speaking and writing, handwriting and typing, computer file and hard copy, etc. Since errors can be introduced at each transformation, the fewer the media transformations, the more accurate the final product. Automated office systems should therefore improve the appearance and accuracy of output.

The quality of work produced should improve even where time savings cannot be demonstrated. Word processing should permit text to be easily corrected and modified, making it possible to improve document quality within given time constraints.

Proposition 2: Automated office systems, especially text processing functions, can permit increased specialization of skills to support administrative and clerical tasks.

The potential exists to reorganize office tasks for increased specialization. The effect of this specialization is highly dependent on the management philosophy underlying the organization of the new systems. On the one hand, the acquisition of word processing skills may be represented as skill enhancement and enrichment of current clerical work. The role of "information specialist" may emerge. Moreover, the decentralized "one-on-one" clerical work force may be replaced by an administrative hierarchy that permits acquisition of new skills and increased opportunities for advancement.

A more negative picture is drawn by the political view of increased specialization. The potential exists for automation to permit an increased division of labor and increased "de-skilling" or routinization of office tasks. In this view the "... office of the future is a recreation of the factory of the past" [54]. The authors, as stated earlier, feel that a management philosophy stressing careful design will prevent these negative outcomes. The potential effects of specialization on individual stress, status, and job satisfaction are discussed in later propositions.

Proposition 3: Automated office systems, especially communications functions, can alter the physical and temporal boundaries of work.

The asynchronous nature of communications with automated office systems has already been discussed. Since physical proximity is not required for many communications and since responses can be asynchronous, the opportunity exists to increase the flexibility of work hours and work location. For instance, if employees were permitted to work part-time at home, there would be potential savings for the organization in terms of office space. Individuals could enjoy increased flexibility and savings in commute time and costs. Several companies are now experimenting with "remote work" options, motivated by the need to attract and retain qualified personnel [43]. Particularly in densely populated urban areas, allowing flexibility in work hours and work location can help to attract qualified individuals who cannot or will not tolerate a long commute to work nine-to-five. Such options provide significant opportunities for the elderly, the severely handicapped, and those with other personal or family responsibilities that constrain their freedom of movement and limit their current work options.

The communications component of automated office systems provides the potential to move entire work units into "satellite work centers," small organizational units located in areas closer to employees' homes. Organizations are considering such options because of the potential savings in costly urban office space and because of the benefits to employees in terms of reduced commuting. Both the satellite work center and work-at-home options invite significant questions about how to manage employees remotely and how work location affects the employee's own job satisfaction; these questions are contained in subsequent research propositions. The important point here is that current technology permits changes in the physical and temporal nature of work that were not feasible previously.

Effects of Office Automation on Individuals

Where the first three propositions focused on the nature of work itself, the propositions in this section are concerned with how automated office systems, influenced by changes in the nature of work, affect individuals' attitudes toward their work.

Proposition 4: Automated office systems can affect the role identification and stress of office workers, especially secretarial and clerical workers.

A recent report [55] cites numerous studies of office workers showing that stress is a major problem in this work group. In particular, the report concludes that machine pacing of work, monotonous, repetitive work, and service work (responsibility for people rather than "things") are major sources of stress. Turner and Karasek [50] identify four characteristics of task environments that affect operator performance and physical health for tasks requiring computer interaction: operator autonomy over control of the work, uncertainty about the system, changed task interdependencies, and overall workload. These characteristics have been identified as stress-related in white-collar jobs [14, 29, 37]. Factors of the task environment specific to automated office systems might be the increased speed of communications with superiors and increased workload through having a greater number of principals to serve per secretary

As discussed under Proposition 3, the degree to which stress-related conditions are enhanced is highly dependent on the organization of the work activities to be supported by automated tools. Turner and Karasek [50] present a number of suggestions for design of systems to decrease stress and improve performance, many of which pertain directly to office automation.

It is expected that there will be little or no increase in role overload or stress for professionals or managers as a result of automated office systems. For managerial workers, one can expect greater time pressures to respond to electronic memoranda that previously would have been typed and transmitted by mail. However, to the extent that electronic mail replaces phone messages, the manager has the opportunity to think and respond to a message without having to react immediately on the telephone. Thus, the advantage of the greater transmission speed combined with the ability to defer reading as well as answering messages should result in greater control over daily interaction when electronic systems substitute for some face-to-face communications [5].

Proposition 5: Automated office systems can affect the perceived status and job satisfaction of office workers, especially secretarial and clerical workers.

Evidence from research on job satisfaction shows that greater satisfaction and higher perceived status can result from increasing the task variety, skill requirements, and direct feedback of a job [23, 25, 47]. If the task environment is organized appropriately, the training involved in the use of automated office systems can represent an upgrading of skills, increased status, and job enrichment for clerical and secretarial workers. Those jobs such as filing that are typically considered the most boring and repetitive can be incorporated into other jobs and eventually disappear altogether.

In the long run, the function of "information specialist" can provide not only an upgrading of skills, but greater opportunity for advancement and increased responsibility. It is conceivable that administrative work will be a significant organizational function with a hierarchy of authority and career paths that do not exist for the typical administrative worker today.

The potential for a negative impact on the status and job satisfaction of clerical and secretarial workers also exists, especially if poor work designs accompany the new systems. Examples exist of centralized word processing systems where secretaries who had previously gained status and satisfaction from support of a particular manager were reduced to membership in glorified "typing pools" and experienced decreases in status and satisfaction with the work [54].

Automated office systems can be designed to either enhance or decrease the perceived status and job satisfaction of affected employees. The automated systems are themselves basically neutral; their implementation provides the opportunity to consider perceived status and job satisfaction in the redesign of the tasks they are to support.

Proposition 6: Changes in the physical and temporal nature of work supported by automated office systems can affect the worker's feelings of identity with organizational goals and criteria for promotability, especially for professional and managerial workers.

The majority of tasks performed by professionals in an organization are project-oriented with relatively long-term deadlines. Many professional functions are supported by computer and communications technology. This proposition is based on the premise that given the nature of their work, many professionals can work in relative isolation from the organizational environment for at least some period of time. While it may be very attractive to a professional to work at home several days a week in relative "peace and quiet," for instance, it is conceivable that such work patterns could discourage organizational commitment and encourage professional autonomy. Such a shift could be very dysfunctional to the organization overall and may also be dysfunctional to individuals; lack of visibility, for instance, may negatively affect their chances of promotion [41].

Effects of Office Automation on Organizational Communications

The next four propositions are concerned with the quality of most forms of communication of a work-related nature.

Proposition 7: Automated office systems, especially communications functions, can lead to improved efficiency of communication for all office employees.

It is expected that use of communications functions, primarily electronic mail, will increase the efficiency of communication through the substitution of electronic memos for telephone communications and written memos. Electronic messages are fast and accurate; they require fewer media transformations than written memos. One effect of electronic mail substituting for telephone communications is reduced "shadow functions" [5], the unpredictable, time-consuming, but "unproductive" activities associated with a telephone call such as a busy signal, the called party being out of the office, or a bad connection. Another mechanism for improving the efficiency of managerial time is "message queuing" [5]. A telephone call often interrupts something else that a manager is doing, causing "wait" and "recycle" time before the original activity is resumed. Electronic mail messages, unlike telephone calls, can be "queued" until the recipient finds the appropriate time to handle them.

Proposition 8: Automated office systems, especially communications functions, can lead to a decrease in the amount of face-to-face contact between a manager and secretary, between colleagues, and between superiors and subordinates.

It is relatively clear that a communications function such as electronic mail can provide a direct substitute for some forms of face-to-face communication. What is less obvious is the effect of removing verbal or face-to-face contact on the quality of a communication. At least one study [11] has shown that the average time required to solve structured logic problems requiring direct communication was less with voice communication than with any other mode (handwriting, typewriter, video) or combination of modes without voice. There was no significant difference between full face-to-face communication and audio-only. On the other hand, studies of the mechanics of interaction in problem-solving have consistently failed to show a significant difference in the quality of the solution with variations in communication mode [10, 46].

The effects of altering the mode of communication on task performance need to be examined in each context before major changes are instituted. While the quality of solution may not decrease, other factors such as the time to reach a solution, the social reinforcement provided by face-to-face contact, and pressure to conform or change one's attitudes may be important in given situations. In general, it is expected that the effects of altering the mode of communication will be more pronounced as one moves on a continuum from structured, task-oriented messages to bargaining or negotiation-type problems, where the messages contain highly subjective material (see Table I).

Proposition 9: Automated office systems, especially communications functions, can lead to an increase in the total volume of communications by organization members.

It is expected that while the total volume of communications may increase because of the ease of transmitting messages, automated office systems will alter the mode and circumstances under which this communication takes place. At least two studies [7, 56] have shown a net increase in volume of communications as a result of automated office systems. Another study [28] showed an increase in the volume of communications among researchers in dispersed locations as a result of the use of computerized conferencing.

Proposition 10: Automated office systems, especially communications functions, can affect the total volume of communications between departments.

Although the amount of interdepartmental communications depends on the structure of the organization, interdepartmental relations, and the nature of task activities, the existence of an electronic mail system or similar communications functions should facilitate communications among departments. However, during the interim period before all organizational units utilize the system or if some units resist using it, there may be decreased efficiency of operations related to that unit due to lack of complete information.

Effects of Office Automation on Management Processes

There are a number of ways that office automation technology can affect superior subordinate relation-

Table I. Classification of Messages.

Characteristic	Type of Message
Rational, thinking ↑	Scheduling, coordinating, facts
	Perform tasks, i.e., bring a paper or book
	Reminder
	Write or respond to memo
	Make an expected request
	Make request beyond call of duty
	Negotiate
	Value oriented feedback on performance, etc.
↓ Feeling, interpersonal skill and competence required	Creative discussion, model building, theory building

ships. Some are direct effects of the technology itself, others are indirect effects mediated by changes in the physical and temporal nature of work.

Proposition 11: Automated office systems, especially communications functions and personal applications, can affect managers' perceptions of the degree of rationality, flexibility, and free space of their work.

Argyris [3] has predicted that information systems and operations research tend to increase the rationality of the manager's job. Automated office systems have the capability to contribute to increased rationality. Following the arguments of Argyris, automated office systems could result in fewer private information systems and less individual discretion in accepting information. Also, one would expect less intentional withholding of information because of the ease of communications. Messages can be transmitted accurately through many individuals and many levels, resulting in less filtering and less distortion of information received by higher management levels. This effect could be personally threatening or disadvantageous for subordinates in situations where they find it desirable to distort or block upward communications [2, 45]. The number of options open to managers for coping with excessive rationality in the organization or for defending themselves against perceived threats from others could be reduced.

Proposition 12: Automated office systems, through their effect on the physical and temporal nature of work, can affect methods for monitoring and controlling work.

A question frequently raised regarding remote work is:how does a manager monitor and control work that is performed out of sight? The answer to this question is highly dependent on the nature of the work being performed. For clerical tasks that can be defined in terms of output, there may be a return to the concept of "piece rates." Much professional work has objectives and milestones defined in terms of "deliverables"; the challenge is to define equitable deliverables within a realistic time frame. Jobs whose controls are defined in terms of process rather than output may simply not be good candidates for remote work. Perhaps a more significant problem is the adjustment in personal management style that would be required to manage remote work. Many managers do not feel comfortable supervising employees they cannot see; regardless of the employee's personal preference or the nature of the task, a job is probably not a good candidate for remote work if the manager does not feel comfortable with the arrangement.

Proposition 13. Automated office systems can be utilized to help increase the span of control of managers.

Increasing efficiency of communications and other office functions should result in greater free time for a manager. Although it can be argued that a manager can make use of that time to make "higher quality decisions," this benefit is difficult to quantify. On the other hand, increasing the number of subordinates reporting to a manager has the distinct advantage of being quantifiable in terms of a reduction in the total number of managers required. Because of this advantage, some companies have cited increasing span of control as a direct goal of implementation of their automated office systems [7]. If a reorganization occurs parallel to the implementation of automated office systems, the increased load on the manager can provide an incentive to utilize the new technology to improve efficiency.

Effects of Office Automation on Interpersonal Relations

The existence of automated office systems is expected to affect the nature of interpersonal relationships within the organization both directly and indirectly.

Proposition 14: Automated office systems, especially communications functions and personal applications, can reduce the quantity and quality of social interaction and social reinforcement in the office.

It is clear from the preceding discussion that automated office systems have the potential to reduce face-to-face interaction through the direct substitution of electronic communication and the indirect effect of alterations in the physical location of work. Social needs play an important part in the motivation of individual workers [36, 38]; however, it is not clearly understood whether that motivation derives from peer group support, especially for professionals, or is purely social. One reason that satellite work centers are favored over, for instance, more extreme remote work options such as work at home is because of the social interaction provided.

Proposition 15: Automated office systems, especially communications functions, can affect the number of "sociometric"[1] links within an organization, the volume of communications among existing links, and the volume of communications upward in the hierarchy.

The availability of a fast and simple communications link should increase the amount of communications flowing along existing paths. This impact can be positive if the communications are satisfactory. If conflict exists or if inappropriate messages are sent, the impact of systems on communications and sociometric patterns could be negative. Another danger is that the increase in upward communication can cause information overload at higher management levels and lack of ability to differentiate significant information. New communications links and sociometric patterns should result from the increased ease of communications. Because communications are easier and faster, the addition of individuals to sociometric groups should be facilitated.

It has been predicted [6] that automated office systems will provide upward accessibility for employees at

[1] Sociometric refers to the number of other individuals with whom each individual interacts.

lower levels in the organization. For instance, with electronic mail employees can easily duplicate electronic messages and send copies to their superiors. It has been shown that upwardly mobile individuals will take advantage of improved communications facilities, possibly as a form of substitute upward locomotion [1, 31, 45].

Effects of Office Automation on Interdepartmental Relations

Proposition 16: Automated office systems, especially communications functions, can affect the degree of interdepartmental conflict, the degree of perceived interdependence among departments, and the definition of departmental boundaries.

The work of Walton and Dutton [52] suggests that withholding of information and other communications obstacles provide a major source of conflict between departments. To the extent that obstacles are mechanical rather than political or emotional, automated office systems provide the potential to reduce barriers to communication across departments and to reduce distortion of task-oriented exchanges, thus effectively reducing interdepartmental conflict.

Departments evolve from the need to specialize organizational activities [22]. High levels of interdependence among departments can lead to one department acquiring high levels of power over another [21, 26]. Conditions of high interdependence can also lead to interdepartmental conflict [52]. Automated office systems should facilitate information flow and exchange which should in turn ease interdepartmental coordination and reduce interdependence. As a result of the impacts expected between groups in the organization, departmental boundaries should also become less rigid [24].

Effects of Office Automation on Organizational Structure and Processes

Given a mature, integrated, organization-wide automated office system, what will be the long-term effects on organizational structure and processes?

Proposition 17: Automated office systems can facilitate changes in the definition of physical organizational boundaries.

The long-term effects of the changing nature of communications may be that individuals can productively contribute to organizational functioning regardless of their physical location. It is conceivable that without the requirement of physical proximity of employees, organizations would have no central physical location but would be composed of many smaller physical entities connected by a telecommunications network. Although this is a rather extreme and futuristic view, organizations are already beginning to take advantage of the lack of physical constraints, primarily through increasing regionalization and the satellite work center concept.

Proposition 18: Automated office systems can help improve the ability of the organization to accommodate structural changes.

This is a logical extension of the previous proposition. Galbraith [22] suggests that increasing information processing capabilities is crucial for coping with organizational uncertainty. Provision of vertical information systems and lateral relations are two organization design mechanisms that facilitate information processing; both of these can be achieved through automated office systems, as suggested by previous propositions. Physical limitations to changing organizational structures should be less critical since the communications capabilities become relatively independent of physical location.

Implications for Research on Office Automation

The descriptive model and research propositions discussed here are meant to provide a meaningful basis for research into the behavioral and organizational impacts of office automation. The propositions have not yet been tested with data. They are meant only to suggest the potentially widespread impact of the new technology. The overall implication is that, unlike many new technological developments which improve organizational efficiency, automated office systems have the potential to bring about profound changes in the nature of organizations.

The authors feel strongly that research focusing on the issues suggested here is urgently needed. Researchers should examine long-term, widespread organizational changes rather than narrowly defined changes in productivity or demonstrable efficiency increases. The authors recognize that such research is difficult, involving longitudinal, detailed examinations of organizations. In addition, the propositions in this paper differ considerably in the effort required to conduct research to assess their validity. For example, it would be very hard to design a study to examine Proposition 18 on structural changes in the organization arising from the implementation of automated office systems.

Research attempts to date have been admirable in the precision with which they attempt to measure or define activities [see, for instance, 4, 12, 13, 16, 33]. However, this research has not attempted to capture more indirect effects of new systems on the nature of work. Studies comparing the effects of different work designs and different implementation strategies are also critical.

Implications for the Design and Implementation of Automated Office Systems

The authors recognize that implementation of automated office systems in organizations will continue and probably increase as productivity improvements are demonstrated. The best strategy implied by the descriptive model of system effects is for implementors to take a broad view of consequences of the new systems.

The systems themselves are not, generally, the "cause" of the types of changes suggested. Rather, the technology is mediated by the design of the work it supports and by the nature of the implementation process. Neither the long-term effects of altering the definition of "work" in space and time nor the consequences of new technologies at work are well understood. It is suggested that some potential problems can be solved by treating the introduction of automated office systems as a problem in work design. Task structures and role definitions can be designed to meet organizational objectives and the technology can be configured to support those work designs. For instance, a work design objective may be to increase specialization of administrative and clerical skills and to create a managerial hierarchy to support administrative tasks; a likely strategy would be to centralize word processing and utilize a reduced staff for other managerial support. On the other hand, increased skill variety and task significance for all support personnel may be a work design goal which would result in decentralization of text processing equipment and training of more personnel. Methods of monitoring and controlling work, especially remote work, can be explicitly considered in the introduction of each new automated office system.

Because the technology is relatively new, many organizations will begin with a prototype office automation project. In order to be as successful as possible with the first applications (which are highly visible), the authors suggest the following characteristics of a high potential prototype application:

1. A high volume of task-oriented communications among users.
2. A significant requirement for coordination of activities within and between departments.
3. High familiarity and good working relationships among those involved with the system.
4. Low levels of conflict among the departments involved in using the system.

The suggestions made here to consider work design alternatives and to pay attention to the implementation process are based on knowledge of computer systems implementation [34, 35]. The authors feel that to provide guidelines for enhancing or minimizing the proposed effects of office automation is premature. It is hoped that research along the lines suggested here can help lead to a set of prescriptions for practitioners that capture the broad scope of impact of this new set of technologies.

Conclusion

Automated office systems can provide a powerful mechanism for increasing productivity and improving the quality of work life by changing the fundamental nature of organizational information processing. The propositions discussed here are meant to provide a starting point for research on the impact of automated office systems. Research should help provide more precise and adequate recommendations for the design of automated office systems so that these systems can be implemented *successfully* and contribute to improvements in organizational effectiveness.

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Who needs the office of the future?

Almost everyone could benefit from the new technology, according to this study of white-collar productivity

Harvey L. Poppel

The office seems to be the last outpost of resistance to automation, if one can judge by the small amount of money companies are now spending on it. Yet more than a trillion dollars will go for salaries and support of white-collar workers in 1982. Booz, Allen & Hamilton Inc., the management and technology consulting firm, studied so-called knowledge workers to determine how they spend their work day and whether the enhancements of the office of the future could make them more productive. Harvey Poppel discusses the results and points out that many of the frustrating, unproductive activities that the study revealed could be reduced by the appropriate mix of new office systems.

Mr. Poppel is senior vice president of Booz, Allen & Hamilton. He specializes in the application of advanced information technology to business.

Illustration by Karen Watson.

"Dammit, Mary, I was within 20 minutes of Quick Industries this morning."

"Well, Mr. Coldcall, I tried to reach you at the field office. It's lucky that you just phoned in. Anyway, a Mr. Buysome at Quick said that if you still want to bid on their contract, you've got to see him tomorrow at the latest and your proposal has to be in by Friday."

"Which proposal? We've talked about three different jobs."

"He said it was the one with the new specs."

"Oh, no! Peter in sales engineering has those at the district office along with the pricing sheets. Please transfer me to Peter. I'll get back to you."

"Sorry, he's on his line; it's busy."

"I guess I'll have to hold, but I'm in a phone booth."

Some minutes later: "Pete? Fred. Listen. I need the Quick specs and pricing. Can you get them to the field office by noon tomorrow? I'll make a special trip in to pick them up."

"Those old things! I suppose I can find them somewhere, but we've changed some of the components and the pricing so I'll have to update them. I'll try to get them to you by the end of the day."

"Pete, you've got to do better than that."

"Sorry, Fred. I'm already working on three other rush proposals, and I'm expediting two other jobs through some bottlenecks in the factory."

"Pete, for Fred's sake, do your darndest! Now please transfer me back to Mary."

"Mary, two things: arrange the delivery with Peter. Then call Joan at the field office. Tell her we're going to have to work late tomorrow night after I come back from my meeting with Buysome. Tell her also to pull the Quick files and proposal boilerplates. She's the only one there who knows where everything is, how to work the word processor, and the high quality copier, and...."

"Oh, Fred, Joan just called me from O'Hare. Remember, she's off to Acapulco? Fred... Fred...are you there?"

Sound familiar?

Fred Coldcall's plight is not peculiar to traveling salesmen. Most "knowledge workers"—professionals like Fred, Pete, Mr. Buysome, and their bosses—find themselves frustrated daily by a seemingly diabolical scheme that scrambles information, information handling equipment, and business people so that they fail to work together at the right place and time.

Yet organizational success hinges largely on how well workers perform their assigned tasks and communicate with one another. The key workers—those who manage, analyze, market, and provide creative thrust—are its knowledge workers, the people who could benefit most from accurate and comprehensive business information and effective communications channels. U.S. businesses will spend more than $1 trillion on white-collar personnel in 1982, and $600 billion of that will go to compensate knowledge workers (see *Exhibit I*).

A few years ago, some executives became intrigued with office automation as the magic formula that would revitalize white-collar functions. Despite the allure, however, businesses are spending less than a nickel for such technology of every dollar of knowledge-worker salaries and internal support costs.

The availability of technology is not the stumbling block. Vendors are already offering a powerful range of electronic devices, software, and communications networks. The fact is that most decision makers are skeptical about what managerial work stations, personal computers, videoconference rooms, and the other, newer icons of office automation can do for their businesses. These executives, disenchanted by their previous exposure to ill-conceived forays into management information systems and word processing, doubt that knowledge workers will embrace the new technology, and they lack confidence that their organizations can channel and measure the intended benefits. In addition, members of the computer-illiterate majority are worried about whether, when, and how they themselves will deal with these new electronic tools.

The evidence from a few innovative organizations, including the U.S. Air Force and several large banks that have made significant office automation investments, offers early, albeit fragmentary, signs that readily accessible information technology can be an antidote for the professional performance malaise.[1] But if most businesses avoid investing in a broadly based office automation program, the electronic office concept could become another overpromised and undelivered remedy full of frustration and expense.

To determine whether performance improvements from office automation are widely achievable and justify the costs and potential trauma of implementation, Booz, Allen & Hamilton recently completed a year-long study of 15 representative large U.S. organizations.

Study methods & systems

We focused on two vital aspects of knowledge worker performance: (1) how these workers now spend their time in achieving their business objectives and (2) how likely they are to raise their productivity through office automation over the next five years. We did 15 case studies in a mix of functional areas such as marketing, purchasing, finance, design and analysis, and personnel. Each study concerned a different type of manufacturing or service business. Six of the seven manufacturers were among the *Fortune* top 100 industrials. Aetna Life & Casualty and the First National Bank of Chicago typified the size and diversity of the eight service businesses we studied.

We treated each case as a detailed feasibility study, reinforced where possible by experiential data. In their automation sophistication the companies ranged from "high" to "nearly none." Each of these organizations, which also included a government agency, partially funded the study. More than 25 information industry organizations, including AT&T, IBM, ITT, and Xerox, also partially funded our efforts but did not participate directly.

We considered five categories of automated office systems:

Conferencing. Telecommunications systems that facilitate human interaction, ranging from basic telephone service to video conferencing.

Information transfer. Electronic message systems in the form of keyboarded characters, facsimile images, or voice.

Information retrieval. Computer-assisted recall of previously stored information, in the form of data, text, graphics, or audio or video input.

Personal processing. Interactive computer-assisted writing, editing, calculating, and drawing, including applications commonly known as word-text processing, personal computing, and interactive graphics.

Activity management. Systems such as electronic tickler files and automated task-project management, which track, screen, or expedite schedules, tasks, and information.

For all these systems, we assumed that knowledge workers could use the technology directly by means of newer, easy-to-use techniques such as touching display screens, manipulating multiaxis con-

1 See Richard J. Matteis, "The New Back Office Focuses on Customer Service," HBR March-April 1979, p. 146; Louis H. Mertes, "Doing Your Office Over—Electronically," HBR March-April 1981, p. 127.

trol levers known as joysticks and mouses, and by having the system recognize their spoken commands. However, when the system was too complex or expensive to use widely at the individual level, we configured an operator-driven system.

To determine how well the five categories of systems fit the 15 subjects, the study team used both quantitative and qualitative techniques. During the 10 to 12 weeks of each case study, the team worked with the executives of the particular departments to isolate the critical success factors (CSFs) in their operations and to become thoroughly familiar with the job characteristics, activities, and attitudes of the 9 to 25 participants.[2]

The participants used a pocket-sized recorder to list and assess their work activities at 20-minute intervals over a three-to-four-week period, and after the study each participant filled out an anonymous questionnaire concerning his or her receptivity to potential office automation changes. Nearly 300 knowledge workers recorded about 90,000 time samples over 3,700 man-days.

These participants closely resemble the U.S. knowledge-worker population: 59% were nonmanagerial professionals, 28% were lower- and middle-level managers, and the rest were senior managers, including 20 at the level of vice president or above. The average age was 41, although 29% were under 35. A plurality (40%) had from 6 to 15 years of tenure with their companies, and the others were evenly divided between those with less than 6 years and those with more than 15 years of service. Of the 78% who had graduated from college, nearly half held advanced degrees.

To establish a broad statistical base of information about current office automation status, plans, and perspectives, the team concurrently conducted two mail surveys of several hundred representative user organizations.[3]

Results of study

We were not surprised that the study revealed no work pattern that neatly fit all levels and types of knowledge workers. Like Henry Mintzberg, who studied the manager's job to separate folklore from fact, we found knowledge workers acting much differently from the classical model of the highly systematic professional who plans, organizes, coordinates, and controls.[4]

Nevertheless, five findings concerning time use amplify Mintzberg's results and have broad managerial implications:

1 **Many of the subjects spend less than half their work time on activities directly related to their functions.** To understand this performance leakage, let's look at how the field sales professionals involved in four of our case studies spend their time. Whether called "account executives," "loan officers," "estate planners," or just generically "salesmen," sales professionals like Fred Coldcall are the spigot for the revenue stream of most businesses. Yet we found that they spend an average of only 36% of their work time on prospecting and selling–activities directly related to generating incremental revenue (see *Exhibit II*). Moreover, they squander much of this 36% on traveling, calling on low-probability prospects, and working through the paper-clogged proposal process.

Both sales professionals and their managers expressed frustration over this poor productivity. Furthermore, they were concerned that their nonrevenue-generating chores were keeping them from cultivating a more lucrative customer base. They thought they had exhausted all the traditional time management techniques they knew but had failed to improve their use of time.

We found that the gremlin is not time management but the awkwardness and imprecision of today's information handling and communication processes. It is easy to see how information problems cost most sales professionals an hour or two a day.

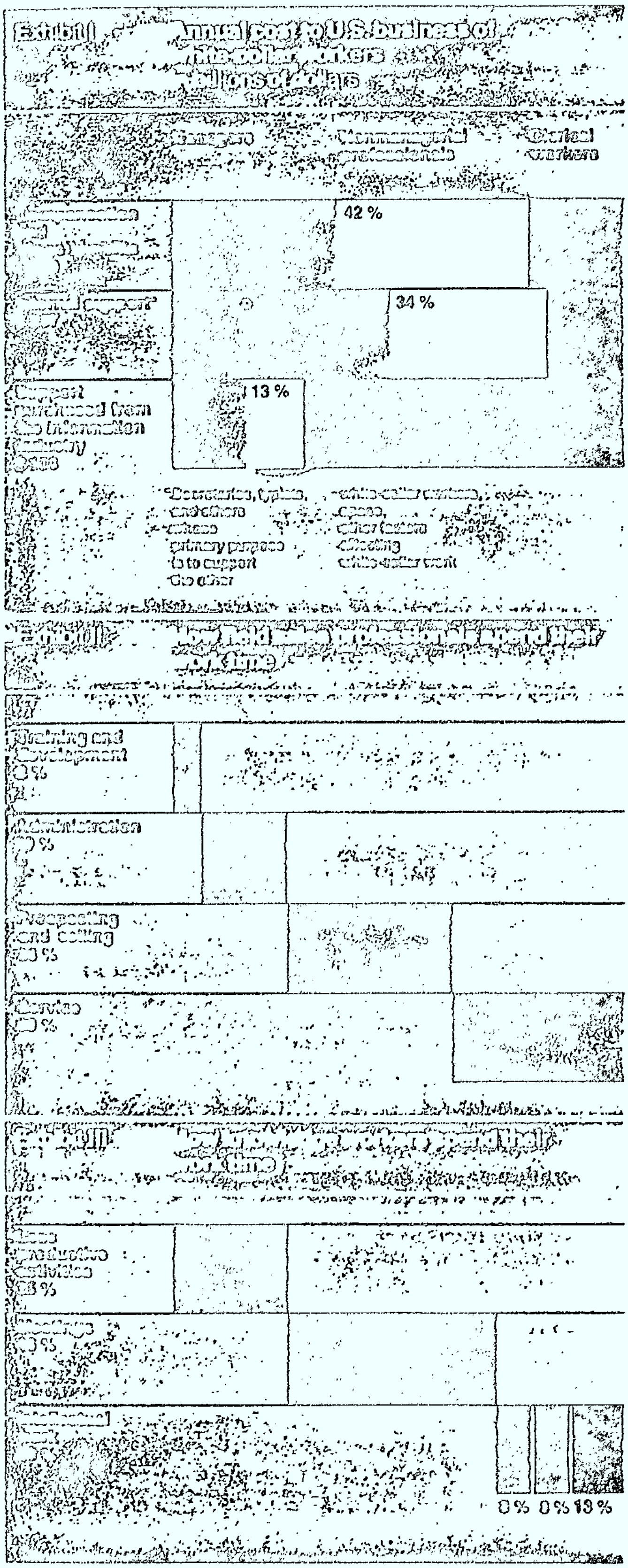
In the first place, many sales professionals select and schedule their calls haphazardly because they lack access to information that might screen and geographically array high-probability prospects. In addition, they often make repeated trips between their offices and customers because they are unable to summon the requisite product, pricing, or delivery information when face to face with the customer. As if this were not enough, they are often obliged to handle, at the behest of customers, such clerical chores as determining the status of an outstanding order or resolving invoice discrepancies. Salespeople are usually pushed into such time wasting because of inadequate clerical support and faulty data processing systems. We found, on average, that such servicing of existing accounts consumed more time than prospecting and selling (39% versus 36%).

Purely administrative chores, such as time and expense reporting, chew up another 19% of work time. And much of this paperwork requires

2 John F. Rockart, "Chief Executives Define Their Own Data Needs," HBR March-April 1979, p. 81.

3 Two surveys conducted by Booz, Allen & Hamilton Inc. during March-April 1980, one in conjunction with the National Office Automation Conference, the other with the Society for Management Information Systems.

4 Henry Mintzberg, "The Manager's Job: Folklore and Fact," HBR July-August 1975, p. 49.



wearying trips to and from the office to receive, file, and mail reports and forms. Finally, training activities – keeping sales professionals up to date on new products, pricing changes, and sales techniques – eat up the remaining 6% of the workday. While continuous training is vital to performance, the communications techniques used today force sales professionals to take lengthy treks to the home office and to wade frequently through a stream of new product specifications, pricing, warranties, and other Brobdingnagian documents.

2 **The subjects spend 25% of their work time on "less productive" activities** (see *Exhibit III*). Three "generic" types of activities, which by our definition are chronically less productive, consume from 18% to 30% of all professionals' time across all the functions in the 15 cases:

Totally unproductive. Mainly the time spent traveling outside or within a building or waiting for meetings to start or a machine to become available. On average, each hour spent at an external site requires an additional 40 minutes of idle travel time.

Quasi-professional. Such activities as seeking information and expediting assigned tasks. These usually require some professional knowledge or interpersonal skills but are often inefficient because either automated or clerical support systems are unavailable.

Productive only at a clerical level. Professionals who lack adequate support must type, make copies, file, and make reservations and appointments themselves. In one case, highly paid R&D administrators were queuing up at an overloaded word processor to type their own progress reports.

Underscoring the importance of inadequate secretarial and clerical support, the results showed that organizations so handicapped consume more than twice as much time on less productive activities as offices that are better supported. In one case, professionals spent 42% of their time on such activities. Their communications-intensive mission was to coordinate operational services for an international commercial banking function. Such findings stress the penny-wise and pound-foolish nature of needlessly harsh cutbacks or across-the-board head count controls of office support staffs.

3 **Meetings, in person and by telephone, are the commonest form of professional activity.** Meetings range from formal training seminars to bull sessions in the hall. Participants spent nearly half (46%) of their working time in meetings, senior managers exceeding 60% and nonmanagerial professionals slightly under 40%. Overall, they conducted 20% of their meetings by telephone. As one might expect,

groups with heavy meeting schedules spent less than average time communicating through exchanges of documents.

4 **Professionals spend on average of 21% of their work time in document-related activities and only 8% on analysis.** Document preparation and review profiles varied widely, owing in part to differences in the availability and quality of word processing for less senior professionals. Nonmanagerial professionals spent nearly twice as much time composing documents as managers did. Also, younger people dictated fewer documents, and professionals who were newcomers spent about 65% more time editing than those who had been in the organization longer.

"Pure" analytical time (time spent contemplating, problem solving, or conceptualizing) is perhaps the most precious and self-rewarding professional activity. But participants spent only 8% of their time in this way. Knowledge workers with some tenure, regardless of their organizational status, spent about 30% more time analyzing than those with little tenure.

5 **Most knowledge workers would like to reshape their time profiles.** Even though most participants and their department heads had distorted perceptions of how they spent their time, many of the managers and professionals we interviewed were eager to find ways of improving their productivity and work quality. For example, in interviews before the time sampling, well over 90% underestimated the time spent in meetings. While a similar percentage overestimated the time they subsequently recorded in analytical tasks, 35% felt they needed to spend considerably more time analyzing (even more time than they had mistakenly estimated). They also considered the time spent in planning and in professional development inadequate.

Despite these needs, participants felt blocked by the hours they squandered on the less productive activities. They especially criticized poorly trained and undermanned support staff, unproductive use of telephones and dictation systems, and inefficient means of document production, which often triggered unplanned and disruptive activities. The participants perceived the widely available computer-generated management reports as being unwieldy, unfocused, and out of date.

Office automation recommendations

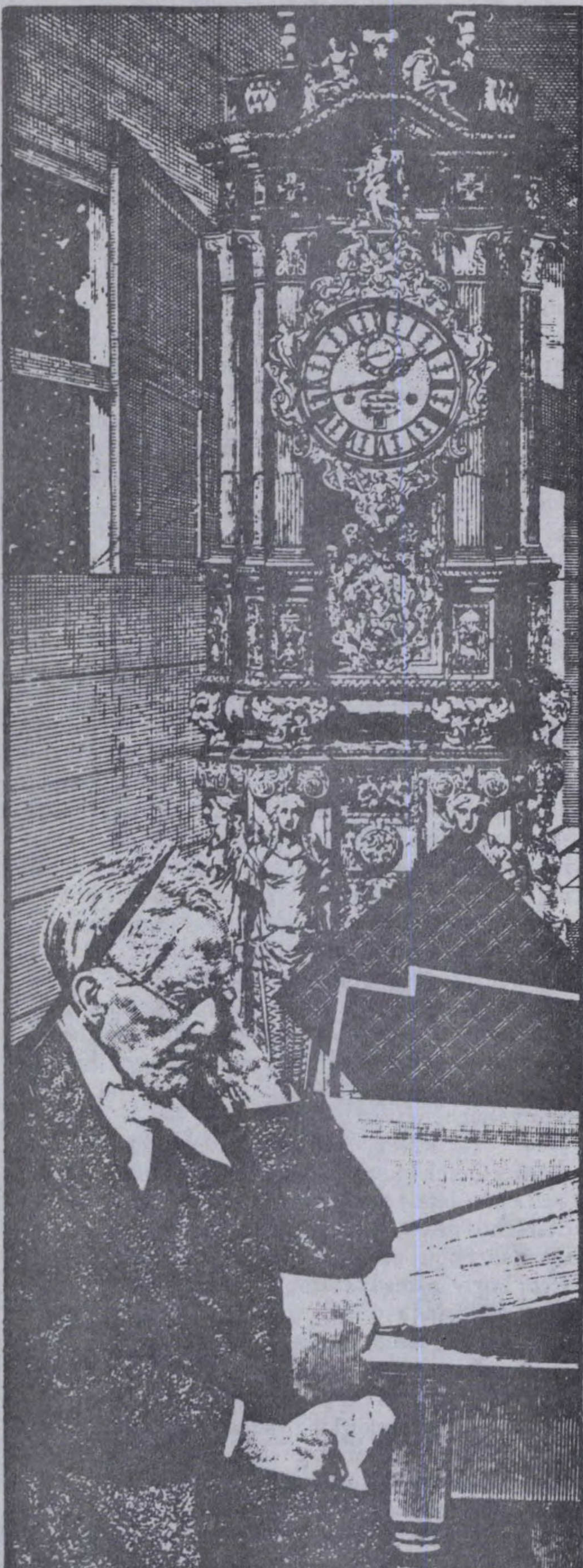
Clearly, many of these findings have implications beyond the feasibility of office automation. The time profiles suggest possible useful adjustments in organizational structure, ways of strengthening supervisory effectiveness, and the assignment of new priorities to activities closely linked to CSFs. Nevertheless, we concluded that within just five years knowledge workers could save an average of 15% of their time through more highly automated support. Roughly half the saving would come from reducing time spent in less productive activities. The balance would derive from selective reductions in certain meetings, analytical tasks, and document handling.

Since field sales is a highly eclectic function that usually embraces most generic activities of other business functions, let us examine a composite of our four field sales cases to illustrate how time savings can be gained.

A sales professional like Fred Coldcall would be equipped with an easy-to-use, portable intelligent display terminal enabling him to access information and contact people in a variety of time-saving ways. First, Fred would scan publicly available data bases to select his prospect lists. Next, a "traveling salesman" algorithm could be used to display a minimum-time travel path among prospects and existing customers. Fred and his office-based assistant, Mary, would use an electronic mail system operating through Fred's terminal to stay in close touch as she scheduled Fred's appointments to match the minimum-travel path. Naturally, the system would reconfigure the path should any appointments be unavailable or canceled. Mary would use her desk-based communicating word processor to send and receive such messages.

Next, Fred would use his terminal while visiting Quick Industries to access the Quick file, as well as the latest specifications and pricing information. Thus he could elicit Mr. Buysome's reaction to the main points of his proposal on the spot and adjust accordingly instead of wasting substantial time and effort preparing a formal proposal. In simpler situations, such as selling personal home insurance, the sales professional could display and print a complete proposal in front of the prospect.

In addition to a portable data terminal, Fred would have a portable telephone that he could use "hands-free" in his automobile and thus convert idle auto travel to productive time. Not only would this unit enable Fred to place and receive telephone calls



while he was on the move but it would also connect him with a central voice message computer. Since this type of system can send and receive messages to and from any telephone, it would enable Fred to communicate with customers and the internal support people who did not have access to a data terminal.

Without having to leave his car, Fred could check the status of an order, coordinate invoice reconciliation efforts, arrange proposal preparations or sales engineering assistance, and even change his appointment schedule at any hour of the day.

Video technology would also help Fred. Full sound and motion product demonstrations on a videodisc would be accessed, along with standard pricing and availability, through an inexpensive videodisc player attachment to Fred's intelligent data terminal. Depending on the type of product, he could view this material with prospects or use it solely to prepare himself. Fred could also keep current with new product and marketing plans by attending video conferences available periodically at a nearby motel.

Certainly, not all these office systems would be useful for every sales force or in other situations. But we did find enough office automation applications (including some not described here) in each case to save at least 10%, and in one case more than 30%, of knowledge workers' time. The two commonest reasons for the savings variations among the 15 cases were the intrinsic differences in functional objectives, company cultures, and work practices and the effectiveness of office support staffs and equipment.

In addition to time savings, we found many opportunities in each case to raise the quality of output. Most of the qualitative benefits link directly to the four CSFs most commonly identified during interviews with executives and other participants:

1 Direct, timely access to accurate product, customer, and internal performance information, primarily by making it accessible through terminals or other types of automated work stations.

2 Effective intradepartmental communications, mainly through electronic mail systems.

3 More effective interaction with customers (both external and interdepartmental), through higher-quality documents and faster message systems.

4 Adequate, uninterrupted time for work activities most directly related to functional objectives, by taking the time saved from less productive activities and reinvesting it in high-priority tasks.

Because of the promise of both time savings and qualitative benefits, we recommended a mix of interdependent applications sufficient to justify a display terminal for 80% of the knowledge workers studied within five years. Few businesses, however, are likely to move that rapidly. As a base point, in 1980 there was only one such device for every 25 U.S. knowledge workers. Nevertheless, Texas Instruments, one of the leading-edge users, reported in 1980 that it already had one electronic information device (a computer terminal or a programmable calculator) for every three white- and blue-collar employees.

Acceptance of automation

We found that acceptance varied according to two criteria: participants' familiarity with the application and the potential for reduction of less productive activities. For example, most participants, especially those who did heavy analytical work and created many documents, were enthusiastic about using such well-known aids as electronic information retrieval and word-text processing. Conversely, less familiar applications, such as video conferencing and electronic mail, appear to face greater resistance (see *Exhibit IV*). A recent market survey indicates, however, that persons who attend many task-oriented meetings are more receptive to video conferencing because of the time it will save them.[5]

Only a handful of participants would be likely to resist all applications. Those with more company tenure, less education, and lower-level positions tended to be less receptive. Surprisingly, once separated from tenure, age was only a minor factor.

On the basis of these findings, we think that organizations can gain maximum acceptance of office automation among knowledge workers by:

Using it to reduce less productive time, which is the greatest source of dissatisfaction.

Involving users and getting their opinions early when selecting and developing new automated systems.

Making no demands for universal acceptance, avoiding personnel shifts that might appear to reduce support service levels, beginning with easy-to-use applications, and starting with intensive user training.

Potential obstacles

Many of the middle managers we surveyed complained that the technology seemed to be getting out of date too fast to ensure a payback. Obsolescence and the incompatibility with newer technology that often comes with it are real prospects. But we concluded that organizations can justify packaged systems, even if the systems' economic levels of use do not exceed four years. True, some key technological developments—which we did not assume to be fully mature in our study—bear watching during the 1980s. Among the most potent are large-vocabulary speech recognition; multiple-panel, high-resolution displays; and the joining of personal computers with videodiscs. Nevertheless, a program of compatible evolution and standards would allow new networks, equipment, and software to coexist with old systems.

As for senior executives, they seem fairly relaxed about the problem of obsolescence. They are more troubled about how to control and measure the benefits. We found that, with strong management, the benefits of automation can be brought to the bottom line. In as soon as one to two years, investments could yield an attractive return. In the case studies, we recommended that businesses commit an average of $8,200 per professional within the first 18 to 24 months, including $6,000 each for new office systems. For financial analysis purposes, we assumed that the cost of new office systems would be amortized as a $1,500 annual operating expense over four years. The remaining one-time costs of $2,200 consisted of project management, physical renovation, software development or acquisition, and training.

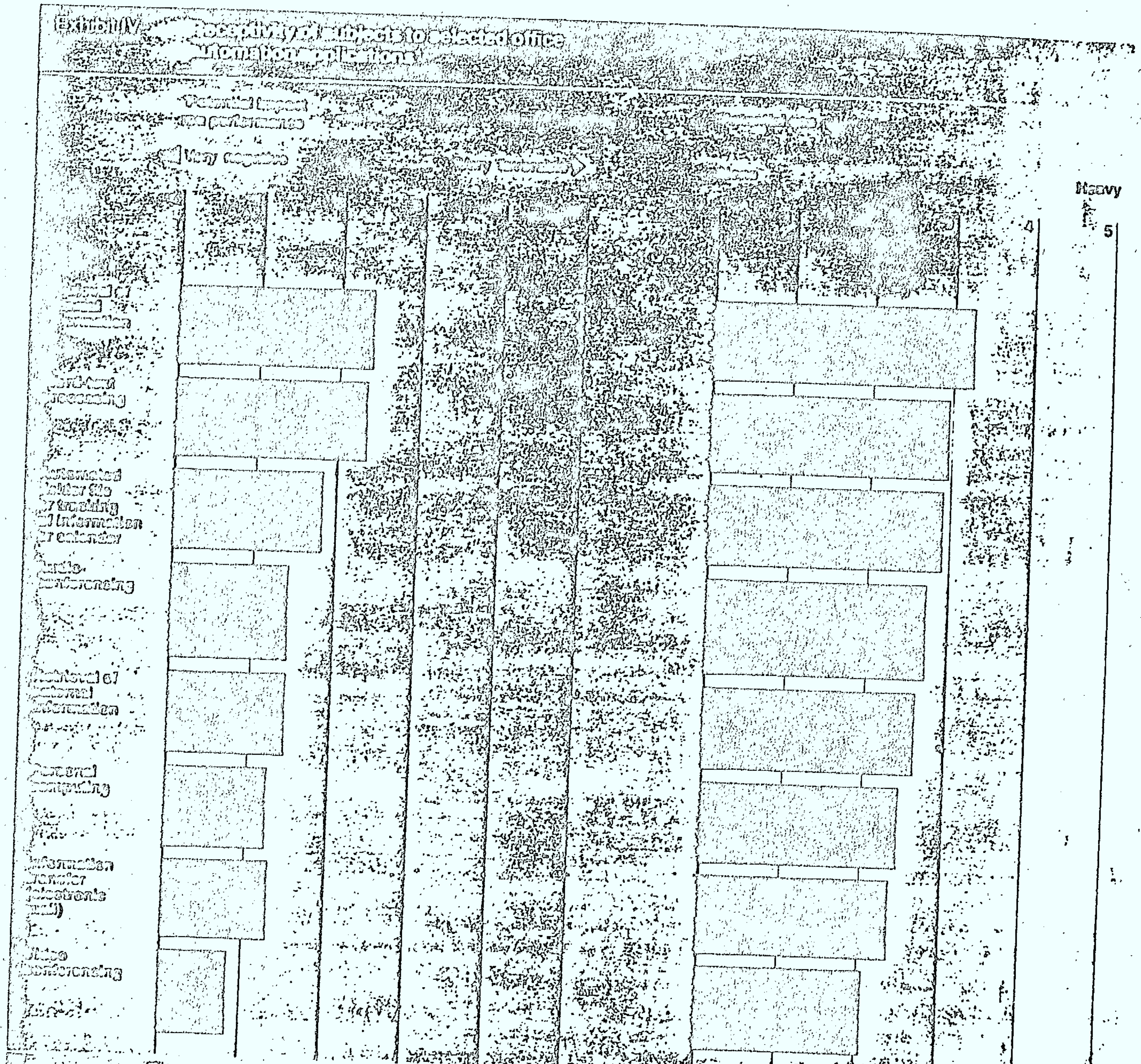
As the compensation value of the estimated annual time savings, we derived a gross annual benefit of $3,400 per professional after the implementation period. To be conservative, we did not factor in any salary increase over this initial 18- to 24-month period. We found a net annual benefit of $1,900 after the subtraction of $1,500 for amortized systems.

On this basis, the average nondiscounted postimplementation payback period works out to 14 to 15 months. This figure varied from 3 to 48 months, however. A more demanding financial test, capitalizing all new office systems costs as part of the investment base, yields an average return on investment of 41%, or well over the hurdle rate of most businesses.

While in theory an organization could stop investing after 18 to 24 months and harvest its

5 Karen File, Alan Kuritsky, Robert Forrest, and Sally Leiderman, "The Future of Videoconferencing: There's More Than the Meeting to Consider," *Teleconferencing and Interactive Media* (Madison: University of Wisconsin Extension Center for Interactive Programs, 1980), p. 37.

6 Parker Hodges, "Fear of Automation," *Output*, August 1980, p. 88.



*Figures are averages of the responses to an anonymous post-study survey, to which 60% of the subjects replied. The subjects were asked to rate the potential impact of the applications on a scale from −5 (very negative) to +5 (very favorable) and the potential use of the applications on a scale from +1 (none) to +5 (heavy).

returns, we found a strong case for reinvesting the early savings in further systems support over a 60-month period. On this basis, the nondiscounted break-even point for the overall program would occur between the fourth and fifth years.

Financial realization of professional time savings can be elusive, however. Indeed, our researchers found that nearly all the companies we studied were already at least two to four years behind in installing available office systems, chiefly because they lacked guidelines for measuring the gains. What is the solution? An organization can reap tangible benefits from time saving by steering the improvements toward overall business goals. For example, a business concerned primarily with cutting operating expenses, as in our information systems case, could use time saving to reduce personnel such as extraexpensive contract programmers.

Businesses will probably seek gains with more strategic leverage. "Most companies," notes David Ness of the University of Pennsylvania's Wharton School, "would prefer a 15% improvement in managerial effectiveness to a 10% cut in clerical overhead."[6] In our field sales cases, we recommended that the time the sales professionals saved by simplifying or offloading servicing and administrative tasks and by reducing travel and time spent with low-probability prospects be reinvested in revenue-generating activities.

Simple arithmetic shows that we could increase prospecting and selling time from 36% to 51% of total time by rechanneling the 15% time savings derived from nonprospecting and selling activities we identified. In theory, this would amount to a 40% boost in revenue-generating potential, so we focused our recommendations for reinvestment on prospecting for new customers, more thorough sales engineering, and "handholding" with existing customers.

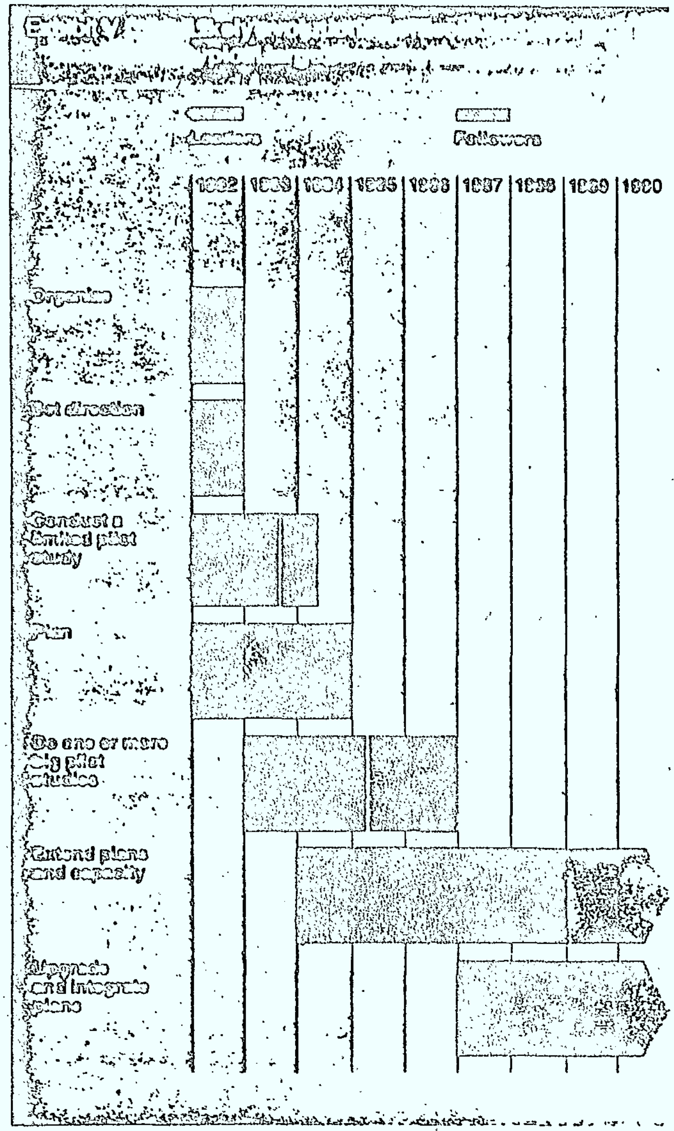
The key to justifying office automation lies in selecting business indicators that best describe the results of either intended reductions in the work force or directed reinvestments of time savings. These indicators are usually integral elements of a management control system, such as revenues and expenses as well as such nonfinancial reinvestment indicators as the number of new products in R&D or the level of customer service and satisfaction in marketing situations.

Staffing problems

Once an organization develops an appealing business case, it will probably find that it lacks qualified designers and implementors. More than 80% of the businesses we surveyed cited this lack as either a major or a minor obstacle. For example, Lincoln National Life recently reported that it had only four full-time people assigned to user training and assistance, despite a well-publicized 1978 commitment to reduce the use of paper 90% by 1984. By early 1980, only 15% of the major U.S. businesses had reported having more than five qualified, full-time office automation professionals on their staffs.

Further, most existing office automation units are attuned not to knowledge-worker performance but rather to secretarial use of word processing and other support systems. And reassigning already scarce computer systems analysts will not fill the entire gap because office automation differs too greatly from conventional data processing.

To overcome the downstream obstacle of inadequate staff capabilities, planners should anticipate the staff they will need to design and implement office systems as well as to guide fledgling end users. As a general guideline, a diversified manufacturer will want to have at least six to ten full-time specialists per billion dollars of revenue. Recognizing the diversity of technical, organizational, and behavioral skills required, companies should cross-train their employees or recruit new talent. They should also seek to learn from the successful experiences of others.



Where to begin

No single approach to performance improvement through office automation can meet the needs of every business or government agency, but successful programs share three features:

1 **Firm commitment from senior management.** A good way of showing early support is to organize a steering committee of senior line and staff end-user executives to ensure that performance benefits are consonant with business strategy and that compatible systems are implemented across organizational lines. Management should then establish, one level below the steering committee, a full-time task force, including general managers thoroughly familiar with business operations, human resource specialists, office facilities experts, and information systems analysts, all

of whom would be responsible for planning the knowledge-worker performance improvement program.

2 **Balance of implementation and planning.** Pilot studies often test the wrong tools on the wrong people and lack the proper controls and measurements. For instance, one manufacturer hurriedly installed an expensive electronic mail system across several dispersed departments only to find that determining and extrapolating the system's impact on professional performance was impossible. Moreover, since the system could not guarantee timely receipt of messages, end users were only lukewarm. Accordingly, the company had no firm basis for extending the program or salvaging its investment.

But realistic comprehensive plans require some hands-on experience. The most successful experiences, such as those at Continental Illinois Bank and in the Air Force, were the result of long-range programs implemented only after careful assessment of pilot studies.

Before implementing even the simplest pilot study, any task force should develop at least a planning white paper, which would establish a general sense of strategy direction and pace and include gross estimates of potential benefits, one-time and continuing costs, and resource requirements. The task force should, above all, select initial showcase work groups and applications, along with a path of how, where, and when to expand applications and the user base.

3 **Time and behavior studies.** Detailed studies will sharpen the gross estimates of time savings, show how to reinvest them, and reveal the potential impacts on work and work-life quality. Then, controlled introductions of off-the-shelf office equipment and software can contribute meaningful before-and-after data. Moreover, as we found in several case studies, the study process leads department managers to important and immediate nonautomated improvements, such as reallocation of office support workloads and heightened emphasis on high-priority business missions.

These first steps are necessary to gain widespread internal support and generate a ground swell of demand. Continental Illinois Bank controlled initial access to its new officer-level information-retrieval system until management was convinced of the system's practicality. When success was demonstrable, other envious knowledge workers queued up to get onto the system. Conversely, hasty attempts to force typing productivity may not only cause performance to fall but also create lingering hostility.

Urgency of automation

Despite strong economic arguments, only a few businesses are likely to hurdle all the obstacles described in the previous sections and achieve larger scale intradepartmental installations over the next year or two. Most will probably not install many interdepartmental, multiapplication systems until the second half of the decade. Even then, only highly aggressive businesses will have companywide installations by 1990 (see *Exhibit V*).

Nevertheless, by starting serious planning now, organizations can benefit early and lay the groundwork for long-term payoffs. Conversely, a laissez-faire approach is likely to result in a flood of localized, ad hoc, and dysfunctional activities.

Even now, some organizations without plans, such as one of the banks we studied, are beginning to suffer from a proliferation of personal computers, electronic mail systems, and word processors that have not been justified, that add little to professional performance, and that are often incompatible with each other as well as with valuable company data bases.

The most valuable lessons to be learned from our research project and the published experiences of others are twofold. First, businesses can improve the performance of knowledge workers significantly and measurably through a carefully conceived and executed office automation program. And second, the patterns of professional activity are complex, eclectic, and dynamic, so any attempt to change them should be approached sensitively, systematically, and at a controlled pace. Hang in there, Fred Coldcall. Help is on the way! ▽

Office of future meets resistance in today's world

At Reliance Insurance Co. and other businesses, high costs, inappropriate equipment and the fears of employees are slowing the advance of automation into the white-collar workplace.

By Larry Reibstein
Inquirer Staff Writer

In July 1980, the folks at Reliance Insurance Co. staged an unusual experiment to see whether employees could go through an entire day without generating a single new piece of paper.

The idea — complete with marshals wearing blue baseball caps and buttons with big red lettering — was part of a highly publicized campaign dubbed Paper Free in '83, a company program to control paper proliferation by relying solely on computers by 1983.

What with all the news reporters and photographers noting the event, Reliance officials were satisfied with that July day and its success at showing employees how much could be accomplished without paper.

But these days Reliance is far from paper-free.

And so are most major corporations in this country, despite the sound and fury surrounding the attempt to move computerized equipment into offices and into the hands of managers and secretarial and clerical workers.

What is defined broadly as office automation is thus far advancing much more fitfully through most companies in the United States than the manager of the office of the future might have you imagine.

Faced with costs that are hard to justify, technology that doesn't always fit and managers who would rather pass up a raise than work a computer, companies like Reliance are finding that bringing computerized equipment into the office is more difficult than the television commercials pretend.

At Reliance, try asking whatever became of the Paper Free in '83 campaign and you'll likely be greeted with smiles, embarrassing pauses and a change of subject.

"It's coming slowly," acknowledged Kenneth Burke, Reliance's director of data processing, who did not appear to be a great fan of the idea in the first place.

"It's still our objective. But some of the hopes were perhaps a little optimistic. . . . We're clearly running behind schedule."

The red "Paper-Free" buttons are tucked away in a closet. The administrative department in which the one-day paper-free experiment was held doesn't even exist anymore — it was split up and its functions passed to others. And throughout the offices of Reliance, paper predominates.

Still, most experts in the field of

(See RELIANCE on 2-F)

Office of future still a far-off dream

RELIANCE, from 1-F

office automation say total automation — with its promised increase in productivity and effectiveness — is still coming. It's a matter of when, not if.

One need only look again at Reliance's 4 Penn Center office, where dozens of computer terminals are scattered around for managers to keep their calendars, communicate with others and do "what-if" decision-making.

Reliance is actually considered one of Philadelphia's more advanced companies when it comes to automating the office.

But for evidence that office automation is an exploding trend, one need only look to Philadelphia's Civic Center this week, where an estimated 20,000 people will gather for an office-automation show that did not exist just five years ago.

The exhibitors will include the nation's biggest computer manufacturers — IBM, Sperry, Burroughs — each of whom has spent millions of dollars developing their computerized devices for the office.

"Most Fortune 500 companies are looking into office automation in one sense or another," said Anne Mayfield, consultant with Arthur D. Little, the Cambridge, Mass., management-consulting firm.

Ironically, the advance of office automation is being accelerated — and confused — by a product that the originators of office-automation equipment had not considered: the personal computer.

"This cross between office automation and the upstart personal computer has really thrown a wrench into the whole office-automation market," said Kenneth Bosomworth, president of International Resource Development, a Norwalk, Conn., market-research firm.

"It's the only part that's beginning to look very lucrative, and the personal-computer boys are beginning to run off with all the loot," Bosomworth said.

Although office automation could be said to have started with the electric typewriter, in many minds it began with the introduction of the word processor, a kind of computerized typewriter with a television-like screen that allows users to compose and revise letters or files rapidly.

At Reliance, there are about 36 terminals used mainly as word processors scattered around the building. But most secretaries still use typewriters, and the company does not appear to have a policy aimed at installing more word processors.

"We're not out selling it," Burke said. "We depend on word of mouth."

As a tool aimed mainly at secretarial work, the word processor today is viewed as just one piece of the totally automated office.

Most of the talk, and products, now center on automating the office of the manager or professional.

That means, ideally, giving an executive a computer terminal through which he can retrieve information on the company, compose memos that he can send electronically to other executives with the push of a button, arrange his calendar, maintain files that he can retrieve instantly and do calculations or budgeting.

Paul Snyder, Reliance's vice president-controller, waxes enthusiastic about his IBM personal computer, which sits in a common space available to several managers.

"I use it for budgeting purposes, for strategic planning, 'what-if' analysis," Snyder said. "We can change a premium and see what happens over the next three, four, five years. We do cash-flow models."

Reliance estimated it has 37 such personal computers, although Snyder and others think that number is ridiculously low. (Indeed, Bosomworth said one survey of 40 companies had found that the actual number of personal computers at companies was typically five times greater than what management thinks. Individuals are buying them behind management's back.)

But as much as Snyder likes his personal computer, he and office-automation purists say several things are missing. The computers don't connect to each other, preventing managers from sending information to others. Also, they are not in the manager's office, a seemingly small annoyance that is actually a major detriment to using them.

"You have to get up and walk out to the cubicle. It's much different to be able to swing around and have the information already there," Snyder said.

Three months ago, Reliance installed about 50 terminals that do link together through the company's main computer. If, for instance, Burke wants to arrange a meeting among three people, the computer will search each person's calendar to find an hour in which all three are free.

Snyder also likes the system because he can study and manipulate company figures himself, rather than wait days for the data-processing department to do it and send him a report.

Yet this particular system is still "fairly complex" to use, Snyder said, relying, as it does, on the data-processing department, which is more comfortable with large-scale computer systems. The complexity puts off computer-wary managers.

"They don't really come out and say, 'I don't want to use it.' They just never get around to doing it," Snyder said.

Fear of change and a feeling that using a keyboard is somehow below an executive's status are other factors constraining the spread of office automation.

"There's a concern that there is nothing serious that an executive can do with it," Burke said. "People might think he's playing 'Star Wars' or something on the screen."

He said that managers also argue that most of their time is spent in one-on-one discussions or in meetings where a terminal would be irrelevant.

In its interim state of automation, Reliance finds itself no different than many other companies.

"You find companies strung out between the 1958 state-of-art and the 1988 state-of-art. There's a 30-year spread in user sophistication," Bosomworth said.

Despite the confusion reigning now, though, Mayfield of Arthur D. Little is convinced that personal computers will make office automation inevitable.

"If companies don't buy them, you can't keep your people from getting their own personal computers to do business work on their own," she said. "You're better off being a step ahead of them."

The Mechanization of Office Work

The office is the primary locus of information work, which is coming to dominate the U.S. economy. A shift from paperwork to electronics can improve productivity, service to customers and job satisfaction

by Vincent E. Giuliano

Mechanization was applied first to the processing of tangible goods: crops in agriculture, raw materials in mining, industrial products in manufacturing. The kind of work that is benefiting most from new technology today, however, is above all the processing of an intangible commodity: information. As machines based mainly on the digital computer and other microelectronic devices become less expensive and more powerful, they are being introduced for gathering, storing, manipulating and communicating information. At the same time information-related activities are becoming ever more important in American society and the American economy; the majority of workers are already engaged in such activities, and the proportion of them is increasing. The changes can be expected to profoundly alter the nature of the primary locus of information work: the office.

An office is a place where people read, think, write and communicate; where proposals are considered and plans are made; where money is collected and spent; where businesses and other organizations are managed. The technology for doing all these things is changing with the accelerating introduction of new information-processing machines, programs for operating them and communications systems for interconnecting them. The transformation entails not only a shift from paper to electronics but also a fundamental change in the nature and organization of office work, in uses of information and communications and even in the meaning of the office as a particular place occupied during certain hours.

Office mechanization started in the second half of the 19th century. In 1850 the quill pen had not yet been fully replaced by the steel nib, and taking pen to paper was still the main technology of office work. By 1900 a number of mechanical devices had established a place in the office, notably Morse's telegraph, Bell's telephone, Edison's dictating machine and the typewriter.

In 1850 there were at most a few dozen "writing machines" in existence, and each of them was a unique, handmade creation. Typewriters were among the high-technology items of the era; they could be made in large numbers and at a reasonable cost only with the adoption and further development of the techniques of precision manufacturing with interchangeable parts developed by Colt and Remington for the production of pistols and rifles during the Civil War. By the late 1890's dozens of companies were manufacturing typewriters of diverse designs, with a variety of layouts for the keyboard and with ingenious mechanical arrangements. (Some even had the type arrayed on a moving, cylindrical element and thus were 70 years ahead of their time.) By 1900 more than 100,000 typewriters had been sold and more than 20,000 new machines were being built each year. As precision in the casting, machining and assembly of metal parts improved and the cost of these processes was lowered, typewriters became generally affordable in offices and homes. The evolution of typewriter usage was comparable to what is now taking place—in only about a decade—in the usage of office computers and small personal computers.

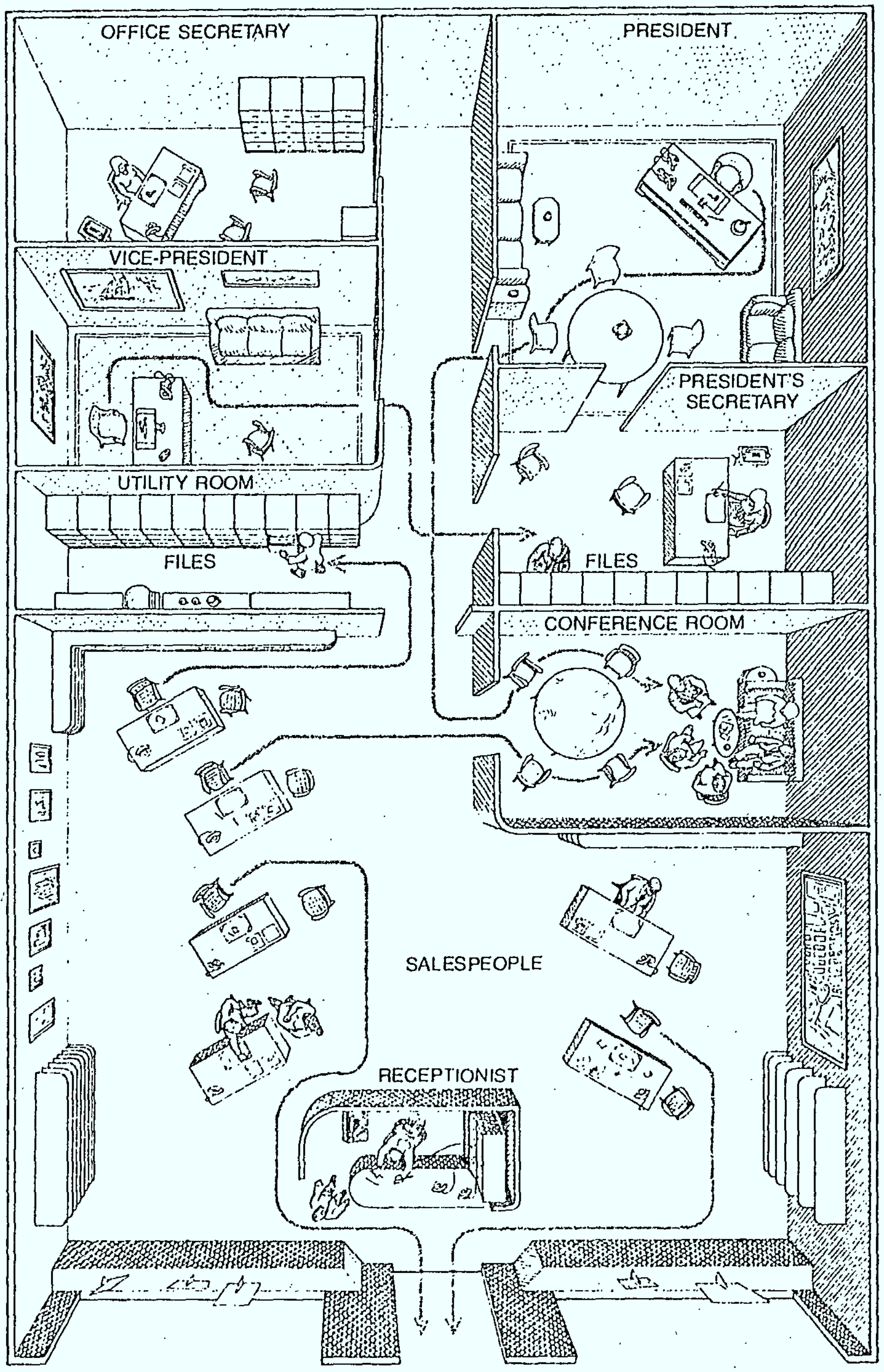
With the typewriter came an increase in the size of offices and in their number, in the number of people employed in them and in the variety of their jobs. There were also changes in the social structure of the office. For example, office work had remained a male occupation even after some women had been recruited into factories. (Consider the staffing of Scrooge's office in Charles Dickens' "A Christmas Carol.") Office mechanization was a force powerful enough to overcome a longstanding reluctance to have women work in a male environment. Large numbers of women were employed in offices as a direct result of the introduction of the typewriter [see "The Mechanization of Women's Work," by Joan Wallach Scott, page 166].

The first half of the 20th century saw a further refinement of existing office technologies and the introduction of a number of new ones. Among the developments were the teletypewriter, automatic telephone switching, ticker tape, the electric typewriter, duplicating machines and copiers, adding machines and calculators, tape recorders for dictation, offset printing presses small enough for office use and data-processing equipment operated with punched paper cards. The new devices were accompanied by a rapid expansion in the volume of office communications and in the number of people engaged in white-collar work.

The first computers in offices were

ELECTRONIC DESKTOP is emblematic of the shift from paper to electronics, the central element in the mechanization of office work. The desktop is displayed on the screen of the Xerox 8010 Star, a personal work station designed for business and professional workers. The Star by itself can serve as a small computer, a word processor and a generator of graphic material; when it is linked to other devices in a local-area network, the Star becomes an information system with access to an organization's electronic files, printers and interoffice and long-distance communications facilities. No special computer skills are needed to operate the work station. The screen shows a number of "icons" (*right*) representing familiar office objects, such as file drawers, file folders, individual documents, an "in" box and an "out" box. The worker sets up his own electronic desktop by manipulating the icons to store documents in folders and drawers, using a keyboard (not shown) and a "mouse" (*bottom*). The mouse is rolled about on the surface of the (nonelectronic) desk to control the position of a pointer on the screen. In the example shown a hypothetical sales manager named Adams has entered his name on the keyboard. His own desktop has been displayed, with a symbol showing there is material waiting in his in box. He has moved the pointer to the in-box icon, pressed the "select" button on the top of the mouse and pressed a key marked "open" on the keyboard, thereby calling up on the screen a list (*left*) of the contents of his in box. Now he can select, read and deal with any of the listed items. For example, he might call up the monthly report, revise it and have it printed.

crude and very expensive by today's standards. By the mid-1960's most large businesses had turned to computers to facilitate such routine "back office" tasks as storing payroll data and issuing checks, controlling inventory and monitoring the payment of bills. With advances in solid-state circuit components and then with microelectronics the computer became much smaller and cheaper. Remote terminals, consisting of either a teletypewriter or a keyboard and a video display, began to appear, generally tapping the central processing and storage facilities of a mainframe computer. There was steady improvement in the cost-effectiveness of data-processing equipment. All of this was reflected in a remarkable expansion of the computer industry. The late 1960's and the 1970's also saw the advent of inexpensive copiers, minicomputers, small and affordable private automated branch exchanges (electronic switchboards), the word processor (the typewriter's successor) and then, toward the end of the 1970's, the microcomputer.

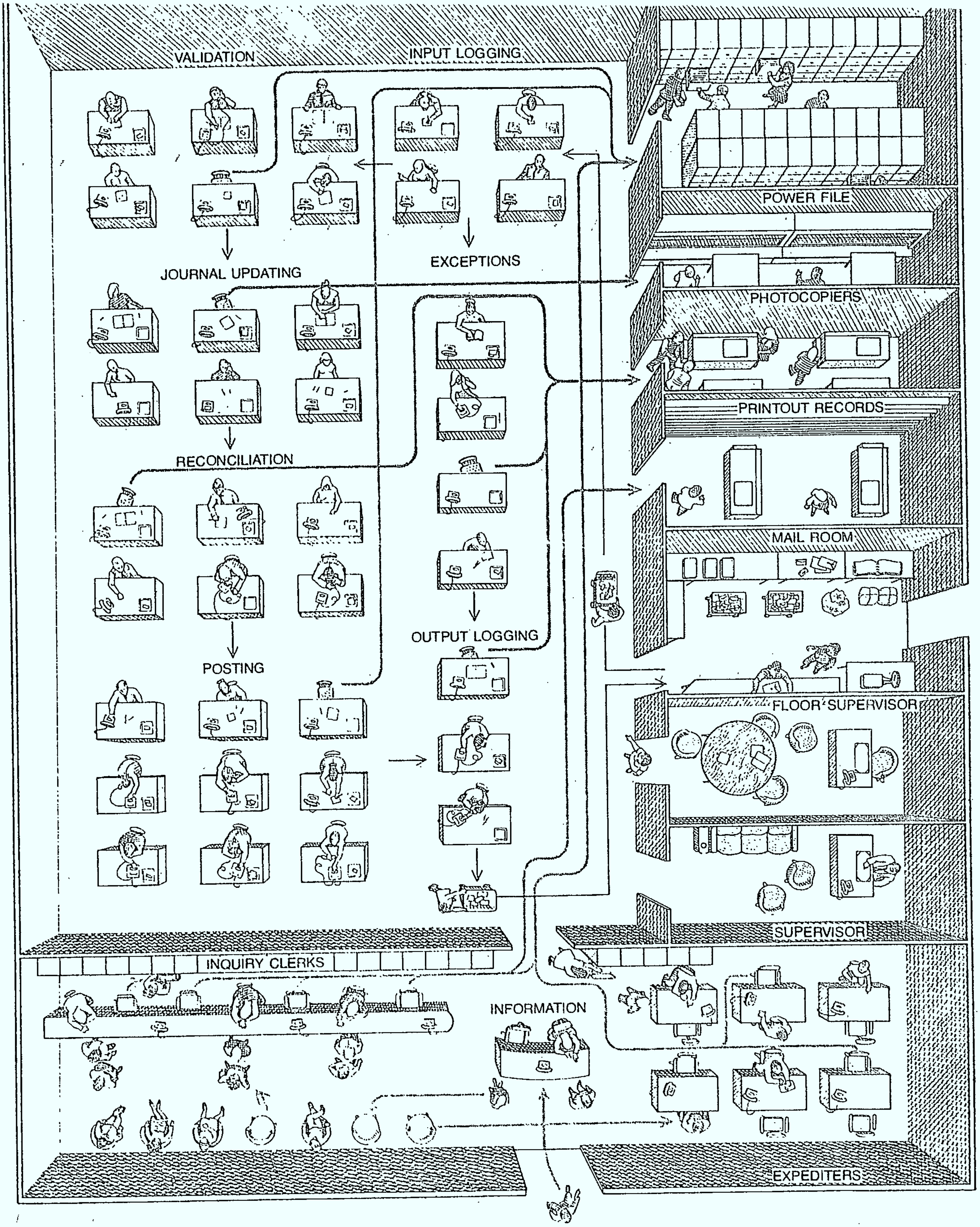


THREE STAGES OF OFFICE ORGANIZATION are defined by the author: preindustrial, industrial and information-age. Preindustrial organization dates back to the mid-19th century but is still typical of most professional, small-business and even corporate-management offices today. It is represented here by a hypothetical real-estate brokerage. There is little systematic organization. Each person does his job more or less independently, moving about as necessary (*gray lines*) to retrieve a file, to take a client to see a property or to attend a meeting where the sale of a house is made final (*color*). Individuals can have different styles of work, and human relations are important. The preindustrial model of office organization can still be effective for some small operations. Conversion to information-age methods is fairly easy.

An anthropologist visiting an office today would see much that he would have seen 25 years ago. He would see people reading, writing on paper, handling mail, talking with one another face to face and on the telephone, typing, operating calculators, dictating, filing and retrieving files from metal cabinets. He would observe some new behavior too. He would see a surprising number of people working with devices that have a typewriterlike keyboard but also have a video screen or an automatic printing element. In 1955 the odds were overwhelming that someone working at an alphabetic keyboard device was female and either a typist or a key-punch operator. No longer. The keyboard workers are both female and male and the typewriterlike devices now accomplish an astonishing variety of tasks.

Some of the keyboard workers are indeed secretaries preparing or correcting conventional correspondence on word processors. Other workers are at similar keyboards that serve as computer terminals. In one office they are managers checking the latest information on production performance, which is stored in a corporate data base in the company's mainframe computer. Economists are doing econometric modeling, perhaps calling on programs and data in a commercial service bureau across the continent. Librarians are working at terminals connected to a national network that merges the catalogues of thousands of participating libraries. Attorneys and law clerks are at terminals linked to a company whose files can be searched to retrieve the full text of court decisions made anywhere in the country. Airline personnel and travel agents make reservations at terminals of a nationwide network. Some of the devices are self-contained personal computers that engineers and scientists, business executives and many other people depend on for computation, data analysis, scheduling and other tasks.

Many of the users of terminals and small computers can communicate with one another and with their home offices through one of the half-dozen "electronic mail" networks now in existence in the U.S. A surprising number of people are doing these things not only in the office but also at home, on the factory floor and while traveling. This article was written with a portable personal computer at home, in a hotel in Puerto Rico and at a cottage in New Hampshire. I have drawn on information from personal files in my company's mainframe computer and have also checked

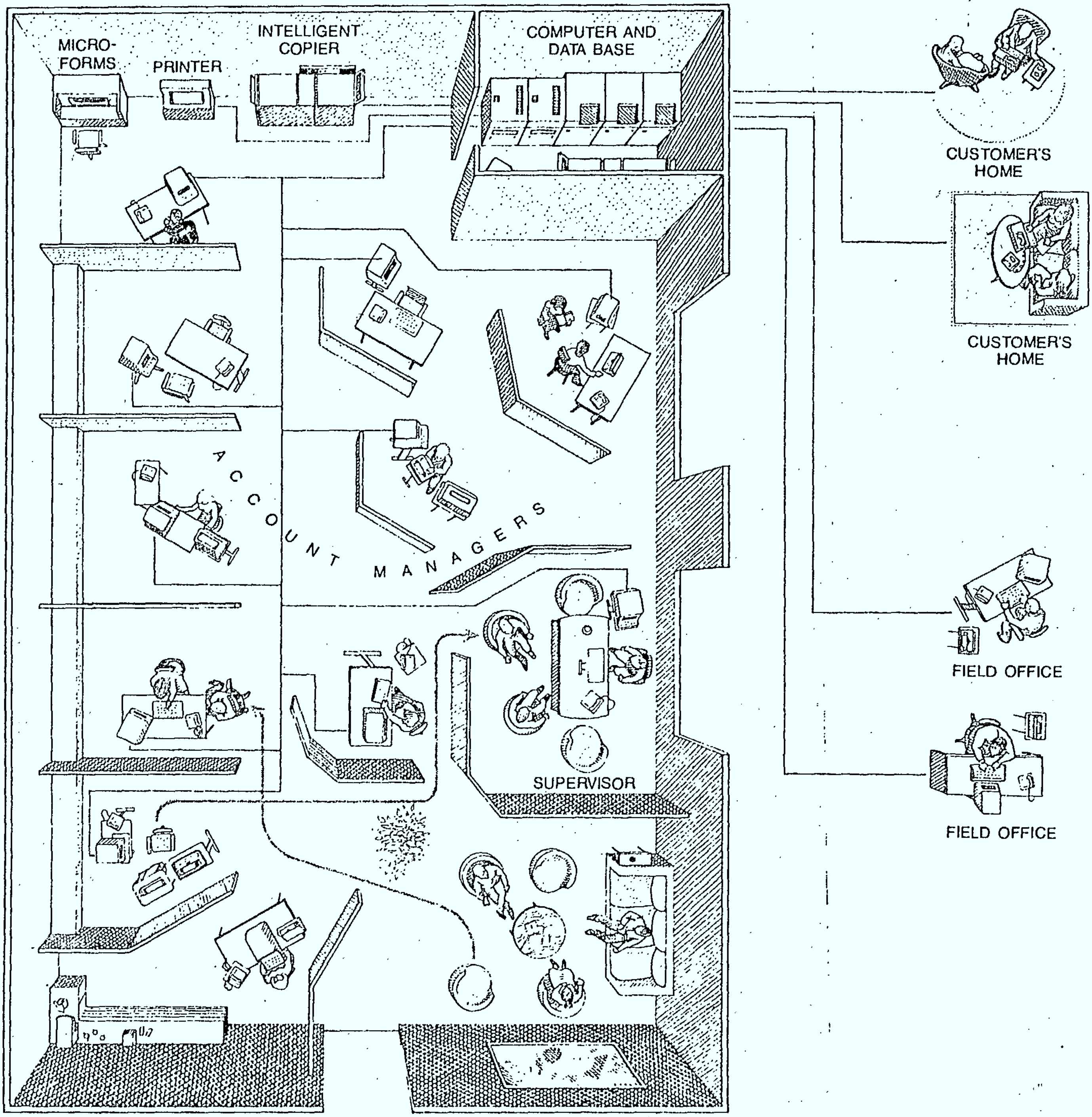


INDUSTRIAL OFFICE, essentially a production line, has been favored for operations handling a large number of transactions, as in this claims-adjustment department of an insurance company. Tasks are fragmented and standardized. Documents are carried from the mail room to the beginning of the production line and eventually emerge at the other end; the flow is indicated by the colored arrows. Successive groups of clerks carry out incremental steps in the processing of a claim; in general they leave their desks only to retrieve files or to examine computer printouts. If clients make inquiries, they are dealt with by clerks who may be able in time to answer a specific question but can seldom follow through to solve a problem. The work is usually dull. The flow of information is slow and service is poor.

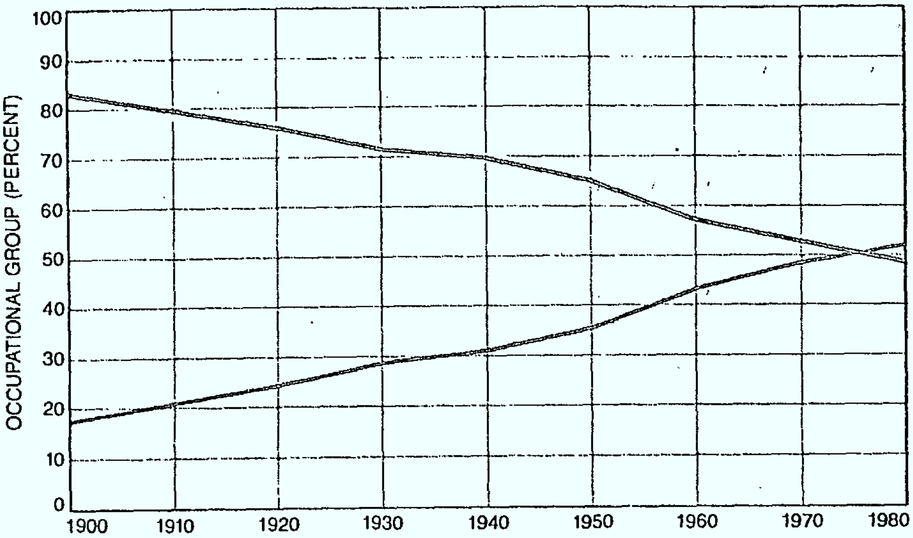
parts of the text with colleagues by electronic mail.

What all of this adds up to is a shift from traditional ways of doing office work based mainly on paper to reliance on a variety of keyboard-and-display devices, or personal work stations. A work station may or may not have its own internal computer, but it is ultimately linked to a computer (or to several of them) and to data bases, communications systems and any of thousands of support services. Today the work stations in widest service handle written and numerical information. In less than a decade machines will be generally available that also handle color graphics and store and transmit voice messages, as the most advanced work stations do today.

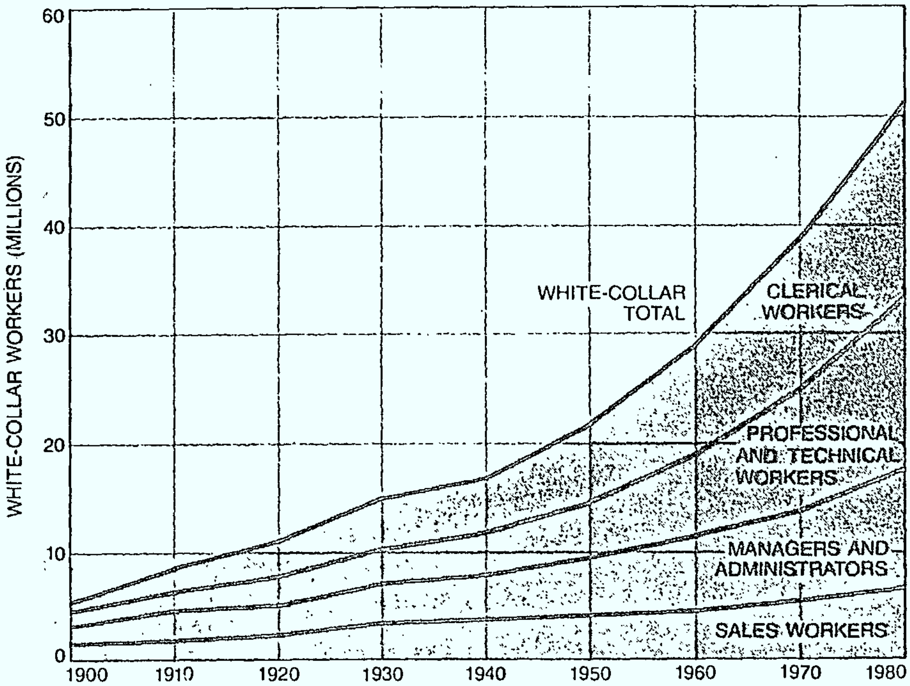
My colleagues and I at Arthur D. Little, Inc., expect that by 1990 between 40 and 50 percent of all American workers will be making daily use of electronic-terminal equipment. Some 38 million terminal-based work stations of various kinds are by then likely to be installed in offices, factories and schools. There may be 34 million home terminals (although most of them may not function as full work stations). In addition we expect there will be at least seven million portable terminals re-



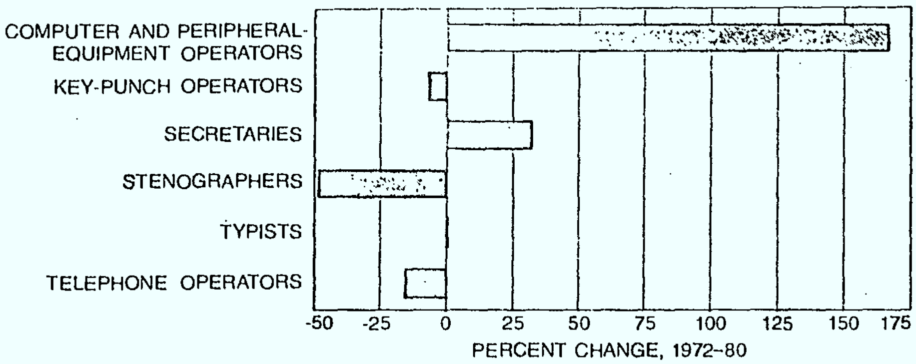
INFORMATION-AGE OFFICE exploits new technology to preserve the values of the preindustrial office while handling a large volume of complex information. The drawing shows an information-age claims-adjustment department. Each adjuster mans a work station, which is linked (*colored lines*) to a computer that maintains and continuously updates all client records. Each adjuster can therefore operate as an account manager, handling all operations for a few clients rather than one repetitive operation for a large number of clients. Necessary action can be taken immediately. Forms are updated and letters are written at the same work station that gives access to stored data, and the forms and letters can be printed automatically. The same facilities are available to adjusters visiting a client's home or working in one of the company's field offices (*right*). The work is more interesting, service to clients is improved and costs are reduced.



WHITE-COLLAR WORKERS now predominate in the U.S. economy. The curves show the percentage of the experienced labor force (from 1900 through 1950) and of all employed workers (from 1960 through 1980) that has been accounted for by workers in white-collar jobs (*colored curve*) and by blue-collar workers, service workers and farm workers (*black curve*).



COMPOSITION OF WHITE-COLLAR GROUP has changed over the years. In 1900 clerical workers were the smallest category; now they are the largest. Most white-collar workers are office workers, and so office productivity has become a matter of increasing concern.



CHANGING NATURE OF OFFICE WORK is reflected in a shift of jobs within the clerical category. The bars show some of the changes from 1972 to 1980. Key-punch operators supply input for older computers. Telephone operators are being displaced by automatic switching.

sembling today's hand-held calculators, most of them quite inexpensive.

Until recently most work stations and their supporting devices and data-base resources were designed to serve a single purpose: to prepare text, access stock-market data or make air-travel reservations, for example. The stockbroker's terminal started out as a replacement for the ticker tape, the word processor as a replacement for the typewriter. The first terminals therefore served as complete work stations only for people who were engaged in a more or less repetitive task.

Now the capabilities of the work station have been extended by developments in the technology of information processing, in communications and in enhancements of the "software," or programs, essential to the operation of any computer system. A variety of resources and functions have become accessible from a single work station. The stockbroker can not only check current prices with his terminal but also retrieve from his company's data base a customer's portfolio and retrieve from a distant data base information on stock-price trends over many years. Millions of current and historical news items can also be called up on the screen. He can issue orders to buy or sell stock, send messages to other brokers and generate charts and tables, which can then be incorporated into a newsletter addressed to customers. It is not only in large corporations that such tools are found. Low-cost personal computers and telecommunications-based services available to individuals make it possible for them to enjoy a highly mechanized work environment; indeed, many professionals and many office workers in small businesses have work-station resources superior to those in large corporations where the pace of office mechanization has been slow.

By the year 2000 there will surely be new technology for information handling, some of which cannot now be foreseen. What can be predicted is that more capable machinery will be available at lower cost. Already a personal computer the size of a briefcase has the power and information-storage capacity of a mainframe computer of 1955. For a small computer an approximate measure of performance is the "width" of the data path, that is, the number of bits, or binary digits, processed at a time. Computational speed can be represented roughly by the frequency in megahertz of the electronic clock that synchronizes all operations in the central processor. Memory capacity is expressed in bytes; a byte is a group of eight bits. The customary unit is the kilobyte, which is not 1,000 bytes but rather 2^{10}, or 1,024. Only three years ago a powerful personal computer had 48 kilobytes of working memory and an eight-bit processor running at a rate of one megahertz.

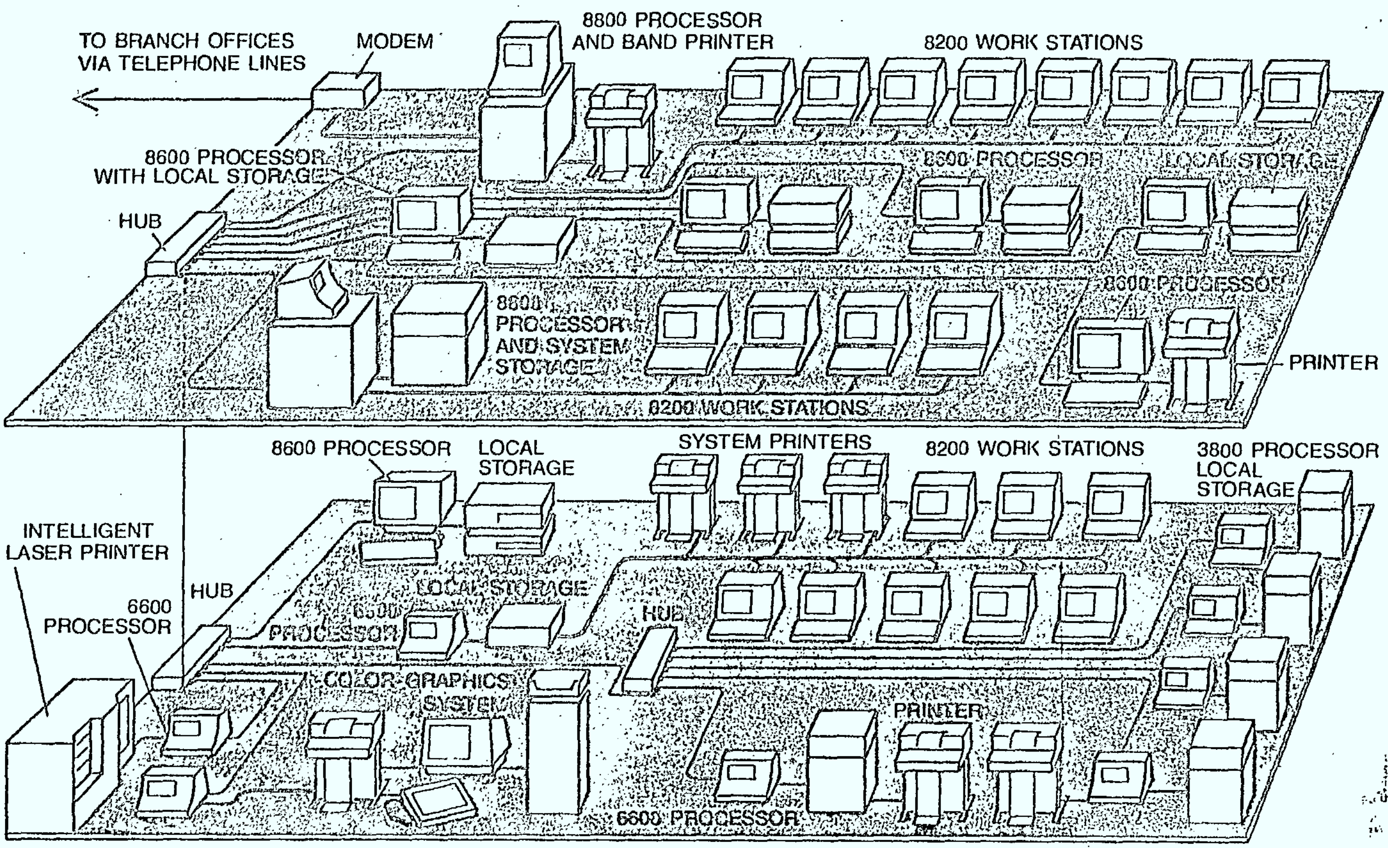
Today about the same amount of money buys a machine with 256 kilobytes of working memory and a 16-bit processor chip that runs at four megahertz or more. Storage capacity and processing power will continue to increase—and their costs will continue to decrease—geometrically. By the year 2000 memory and processing power should be so cheap that they will no longer be limiting factors in the cost of information handling; they will be available as needed anywhere in an organization. The next 20 years will also see the continuing extension of high-capacity communications, of networks for the exchange of information between work stations and other computers and of centralized data banks. Together these developments will provide access to information, to processing capacity and to communications facilities no matter where the worker is or what time it is.

New technology inevitably affects the organization of work. One can define three evolutionary stages of office organization, which I shall designate preindustrial, industrial and information-age. Each stage is characterized not only by its technology but also by its style of management, personnel policies, hierarchy of supervisory and managerial staff, standards of performance and human relations among office workers and between the workers and their clients or customers.

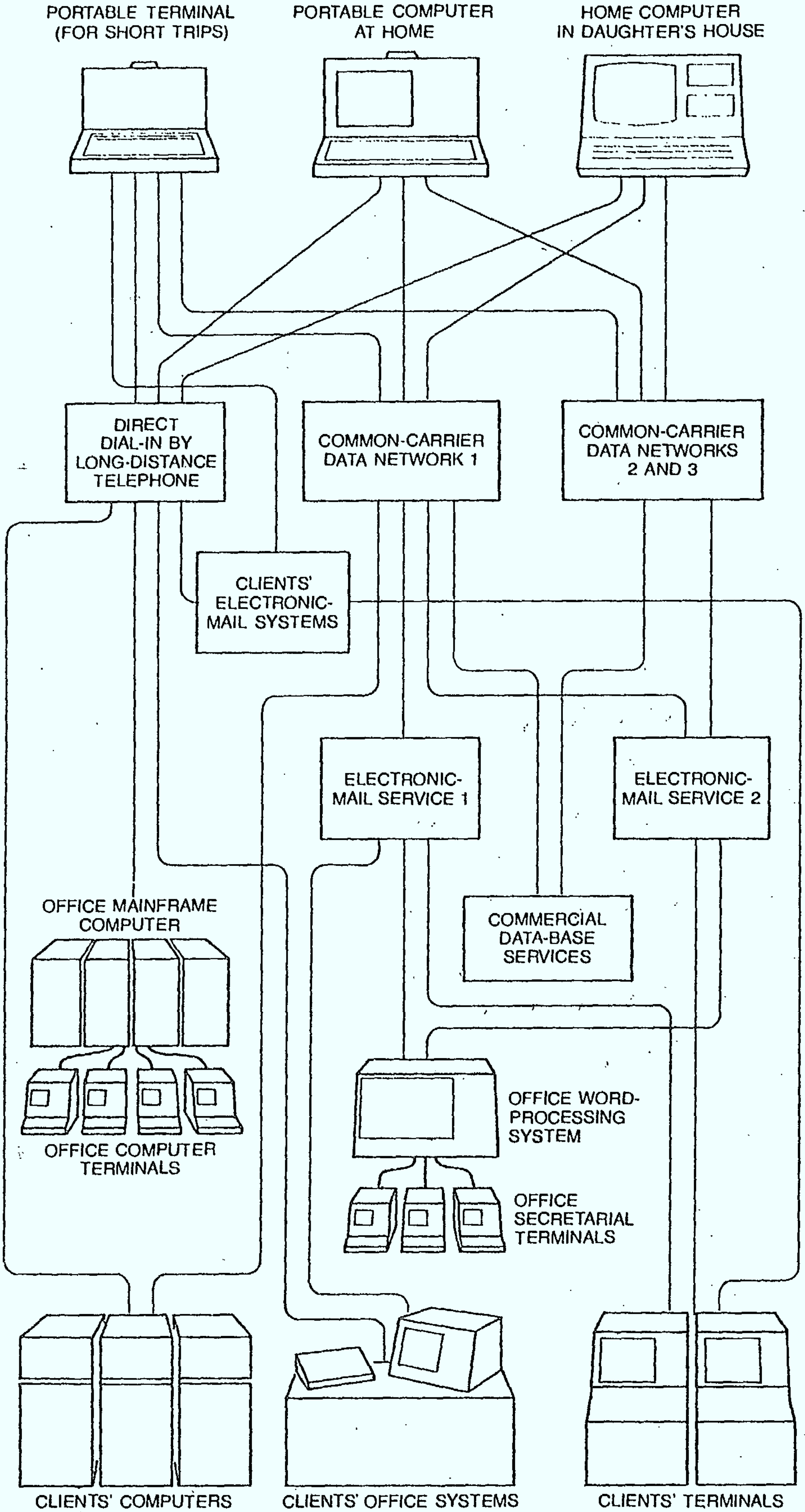
The first two stages correspond to the well-understood artisan and industrial models of production; the nature of the third stage is only now becoming clear. The operation of a preindustrial office depends largely on the performance of individuals, without much benefit from either systematic work organization or machines. The industrial office organizes people to serve the needs of a rigid production system and its machines. The information-age office has the potential of combining systems and machines to the benefit of both individual workers and their clients.

Most small-business, professional, general-management and executive offices are still at the preindustrial stage. In a preindustrial office little conscious attention if any is paid to such things as a systematic flow of work, the efficiency or productivity of work methods or modern information technologies. What information-handling devices are present (telephones, copiers and even word processors) may be central to the operation, but there is no deliberate effort to get the maximum advantage from them. Good human relations often develop among the employees; loyalty, understanding and mutual respect have major roles in holding the organization together. An employee is expected to learn his job, to do what is wanted and needed and to ask for help when it is necessary. Varied personal styles of work shape the style of the operation and contribute to its success.

Preindustrial office organization generally works well only as long as the operation remains small in scale and fairly simple. It is inefficient for handling either a large volume of transactions or complex procedures requiring the coordination of a variety of data sources. If the work load increases in such an office, or if business conditions get more complex, the typical response is to ask people to work harder and then to hire more employees. Such steps are likely to be of only temporary benefit,



LOCAL-AREA NETWORK makes it possible for a large number of work stations in an organization to communicate with one another and to exploit the same data-storage and peripheral equipment. The system shown is the Datapoint Corporation's ARC (for "attached resource computer") network, in which as many as 225 processors (computers) can be linked by a system of coaxial cables (*colored lines*) and interfacing devices. Each processor in turn can be linked by wire (*black lines*) to a number of work stations, storage units or peripheral devices. Each processor has a "resource interface module" (RIM) by which it is connected to a cable leading to a "hub"; each input-output port (*black dots*) on a hub can be connected to a RIM or to another hub. Each RIM has an identification number and attends to any transmission addressed to that number. Traffic is controlled by a "token passing" scheme. Each processor controls the network in turn, taking over to transmit a brief packet of digital signals when it receives a token-passing message from the processor just ahead of it in line. In the system diagrammed here the resources shared by all the devices in the network include magnetic-disk storage units, printers, a generator of color graphics and a modem: a modulator-demodulator that converts digital signals into acoustic signals for transmission over telephone lines. There are also "local" disk units for storing material that is needed only by a single processor.



AUTHOR'S PERSONAL NETWORK enables him to work not only in his physical office but in a "virtual" office, which is to say almost anywhere and at any time. His own work station can be a portable terminal or either of two personal computers (*top*) or a work station in his physical office. Communication among physically separated elements of the network is by way of the public telephone system, with digital signals being converted into acoustic signals by portable acoustic couplers or modems. The author can write and edit material on any of the terminals and send it to his office or to clients. He can call up on the screen of a terminal any material stored in memory units at the office or in a commercial data base to which his company subscribes. He can also send and receive messages through two electronic-mail services.

however. Without the help of additional systems or technology, effectiveness and morale may soon begin to break down.

One response to the limitations of preindustrial office organization has been to bring to bear in the office the principles of work simplification, specialization and time-and-motion efficiency articulated for factory work some 70 years ago by Frederick W. Taylor. The result is the industrial-stage office, which is essentially a production line. Work (in the form of paper documents or a folder of papers related to one customer) moves from desk to desk just as parts move from station to station along an assembly line. Each worker gets a sheaf of papers in an "in" box; his job is to perform one or two incremental steps in their processing and then to pass the paper through an "out" box to the next person, who performs the next steps. Jobs are simple, repetitive and unsatisfying. A worker may do no more than staple or file or copy, or perhaps check and confirm or correct one element of data. And of course everyone has to work together during the same hours in the same office to sustain the flow of paper.

The production-line approach has been considered particularly suitable for office activities in which the main job is handling a large volume of customer transactions, as in sending out bills or processing insurance claims. Many large production-line offices were instituted in the early days of computerization, when information had to be gathered into large batches before it could be processed by the computer; input to the machine then took the form of punched cards and output consisted of large books of printouts. Because early computers could do only a few steps of a complex process, the industrial office had to shape people's tasks to fit the needs of the machine. Computers and means of communicating with them have now been improved, but many large transaction-handling offices are still stuck at the industrial stage.

The industrial model of office organization is based on a deliberate endeavor to maximize efficiency and output. To create an assembly line the flow of work must be analyzed, discrete tasks must be isolated and work must be measured in some way. There is a need for standardization of jobs, transactions, technologies and even personal interactions. A fragmentation of responsibility goes hand in hand with bureaucratic organization and the proliferation of paperwork. Most of the workers have little sense of the overall task to which they are contributing their work, or of how the system functions as a whole.

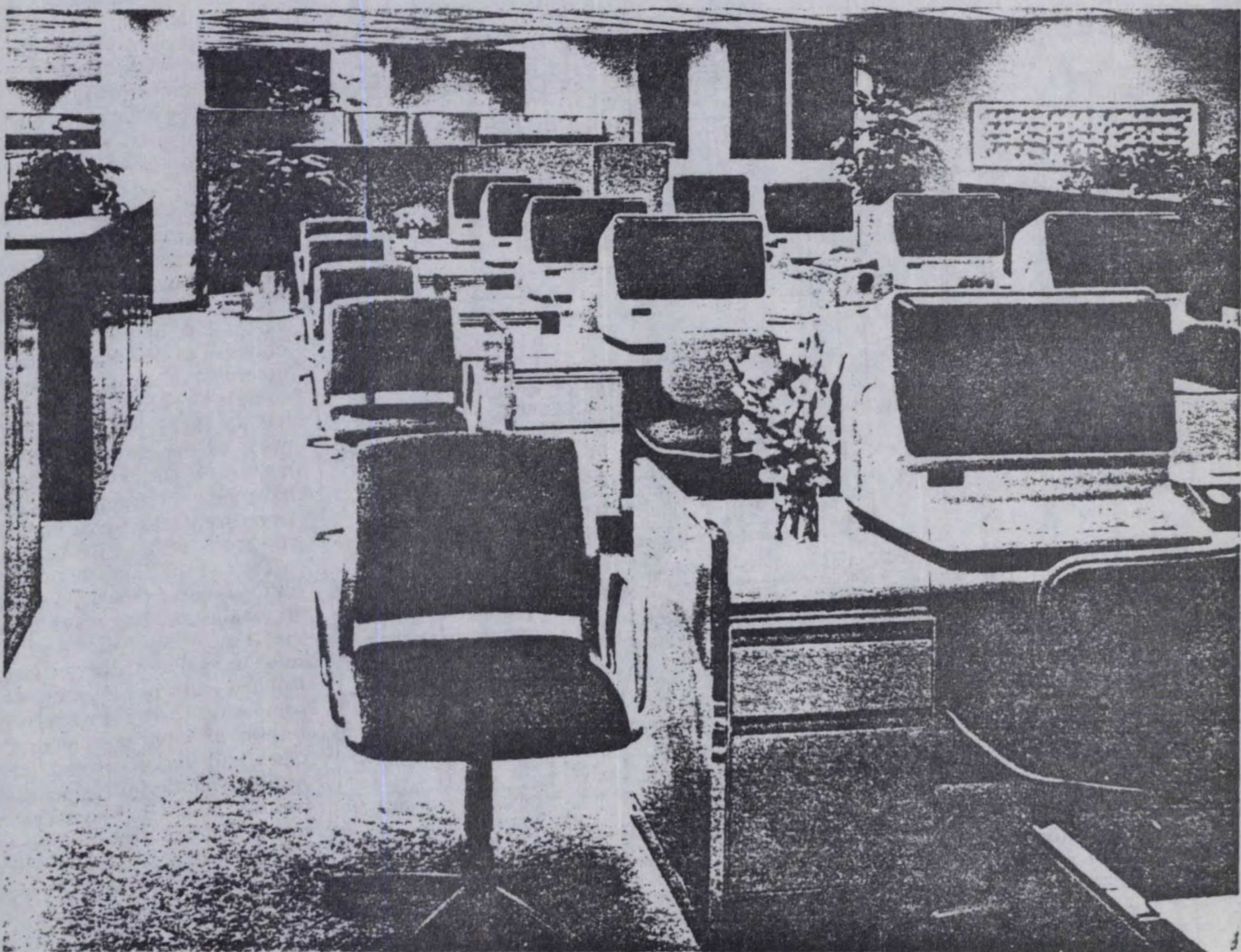
The industrial office has serious disadvantages. Many errors tend to arise in a production-line process. Because of the subdivision of tasks efforts to correct errors must often be made without access to all pertinent information, with the result that the errors are sometimes not corrected but compounded. Moreover, production-line operations can be surprisingly labor-intensive and costly. As more people are hired to cope with an error rate that increases faster than the volume of transactions, the cost per transaction increases and efficiency declines.

Effective people do not want to stay in boring jobs; people who do stay often lack interest in their work, which becomes apparent to the customer. Even if workers do their best, the system may defeat them, and customer service is likely to be poor. Because a given item can take weeks to flow through the pipeline it is often difficult to answer customer inquiries about the current status of an account and even harder to take corrective action quickly. For example, a clerk may be able to check a sales slip and agree that a customer's bill is incorrect; in many instances, however, the clerk is able to change the account only by feeding a new input into the production line, with little assurance it will have the desired effect. As a result the billing error can be adjusted incorrectly or can be repeated for several months.

In the mid-1970's the recognition of these limitations, combined with the availability of new work-station information systems, motivated a few progressive banks and other service organizations with a heavy load of transactions to take the next step: they converted certain departments to a mode of operation more appropriate to the information age. The information-age office exploits new technology to preserve the best aspects of the earlier stages and avoid their failings. At its best it combines terminal-based work stations, a continuously updated data base and communications to attain high efficiency along with a return to people-centered work rather than machine-centered work. In the information-age office the machine is paced to the needs and abilities of the person who works with it. Instead of executing a small number of steps repetitively for a large number of accounts, one individual handles all customer-related activities for a much smaller number of accounts. Each worker has a terminal linked to a computer that maintains a data base of all customer-related records, which are updated as information is entered into the system. The worker becomes an account manager, works directly with the customer and is fully accountable to the customer.

Information is added incrementally to the master data base. The stored data are under the control of the worker, who can therefore be made responsible for correcting any errors that arise as well as for handling all transactions. Since information is updated as it becomes available there is no such thing as "work in process," with its attendant uncertainties. An inquiry or a change in status can be handled immediately over the telephone: the sales slip can be inspected, the customer's account can be adjusted and the bill that is about to be mailed can be corrected accordingly.

The design of effective systems and the measurement of productivity are

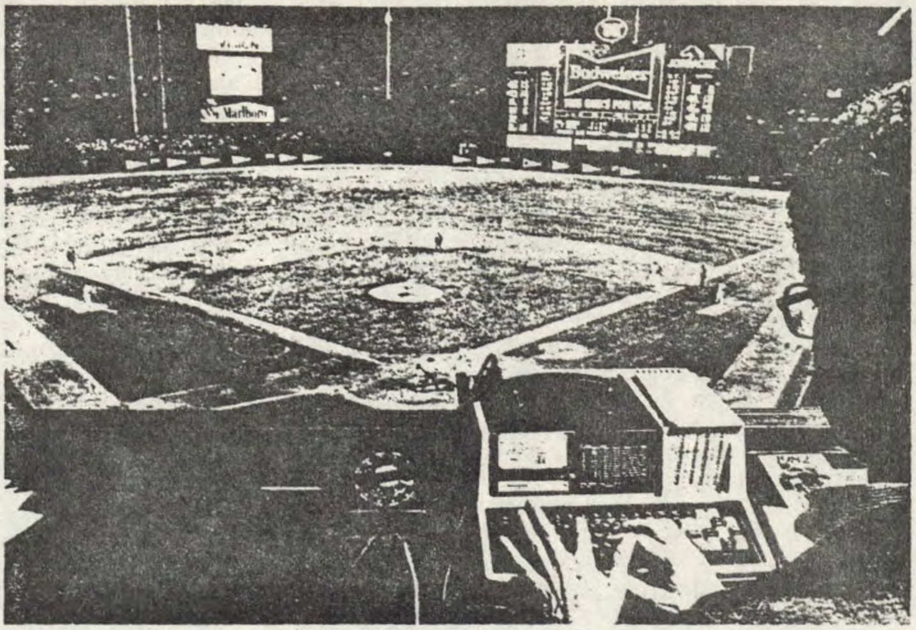


COMPUTER TERMINALS have a conspicuous place in an office of the Prudential Insurance Company of America in Parsippany, N.J., where claims are processed. Personnel who have identified themselves by entering a password at the keyboard of a terminal can retrieve information on an insured person's policy and claim, modify the information as necessary and add new information to the file.

still important in the information-age office with a large volume of transactions, but the context is different from that of the industrial office. Productivity is no longer measured by hours of work or number of items processed; it is judged by how well customers are served. Are they satisfied? Are they willing to bring their business back? Are they willing to pay a premium for a high level of service?

To the extent that the answers are yes the company gains an important competitive advantage. Even if cost cutting is not the only objective, the company can expect dramatic savings in personnel costs. Staff reductions of as much as 50 percent have been common in departments making the changeover to a work-station system. Those employees who remain benefit from a marked improvement in the quality of their working life.

The benefits of the information-age office are not limited to the transaction-intensive office. A similar transformation can enhance productivity, effectiveness and job satisfaction in offices concerned with management, general administration and research. Most such offices are still in the preindustrial stage. They can be transformed to the information-age stage by the introduction of such person-centered technologies as the work station and electronic mail.



PORTABLE TERMINAL is used by Malcolm Moran, a sports reporter for *The New York Times*, to cover a game at Shea Stadium between the New York Mets and the Montreal Expos. The terminal, a Portabubble 81 made by the Teleram Communications Corporation, is carried on out-of-town assignments by most *Times* reporters. Its magnetic-bubble memory holds between 9,000 and 20,000 words. The reporter can keep notes in the terminal's memory and write part of a story and store it for later transmission; he can have background material transmitted to him from the *Times*. Ordinarily the sports reporter writes his article at the end of the game and then transmits it to the computers at the *Times*. Sending and receiving is by means of an acoustic coupler. To file his story the reporter dials a telephone number and gets a go-ahead signal. Then he puts the telephone handset on the coupler and presses a button; the coupler converts the terminal's digital signals into acoustic signals and the story is transmitted at a rate of 300 words per minute. From the *Times* computers the article can be called up on terminals in the newsroom for editing and sent to the composing room for electronic typesetting.

Once most of the activities of a job are centered on the work station the nature of the office can be transformed in still another way: there is no longer any need to assemble all workers at the same place and time. Portable terminals and computers, equipped with appropriate software and facilities for communication (including the telephone), create a "virtual" office, which is essentially anywhere the worker happens to be: at home, visiting a client or customer, in a hotel or even in an airplane. The remote work station can communicate electronically with the central office and so it extends the range of places where written and numerical material can be generated, stored, retrieved, manipulated or communicated.

The effects of small-computer technology on the locale of work are analogous to those of the telephone. Because of the almost universal distribution of telephones it is not necessary to go to the office to call a customer or a co-worker, but until now it has been necessary to go there to write or dictate a letter, to read mail or to find something in a file. Now the work stations and ancillary electronic devices of an automated office can be linked to external terminals and personal computers. The job is no longer tied to the flow of paper across a designated desk; it is tied to the worker himself. The individual can therefore organize his own time and decide where and when he wants to do his work. Individuals who work best early in the morning or late at night can do so. A project team I have been working with for about a year has members in several East Coast and West Coast cities and rural areas, and we communicate regularly by electronic mail. The cost of the correspondence is about a tenth of the cost of regular mail per item, and it turns out that about half of the messages are generated outside of offices and outside of conventional working hours.

What will happen to the physical office? It has its virtues, after all. The office provides a home for organizations, a place for people to come together face to face and a work-oriented environment away from home. Many people need the structure of an office schedule; they like (or at least they are accustomed to) compartmentalization of the day and the week into time for work and time for other activities. Another role for the office is to house centralized forms of communications technology, such as facilities for video conferences, that are too expensive for the home. For these reasons and others I think the physical office will remain a part of working life, at least for as long as I am working. There will be continuing change, however, in how often some workers go to the office and in why they go there.

Many powerful factors are operating together to propel the transformation of office work. A complex set of feedback loops links economic and social change, new developments in information technology, the widespread adoption of the technology and the introduction of the new office organization the technology makes possible. The large number of information workers, for example, stimulates interest in enhancing their productivity. The concern for productivity serves to increase demand for technologies that can reduce the cost of handling information. Thus several trends reinforce one another to generate an ever stronger market for information products and services. The infiltration of the new devices into the workplace in turn creates an environment in which working electronically is the normal expectation of the worker.

Economics is a major factor. It is becoming far cheaper to communicate electronically than it is to communicate on paper. The transition to word processing from multidraft secretarial typing can reduce secretarial costs from more than \$7 per letter to less than \$2. Even more dramatic savings are associated with electronic mail, which can bring the cost of sending a message down to 30 cents or less. Electronic filing, in which a "document" is stored and indexed in a computer memory, brings further savings. (The highest-cost activities in manual correspondence are making multiple copies, filing them and retrieving them.) Such obvious reductions in cost are overshadowed by the savings in the time of managers and executives, the largest element by far in the cost of running an office.

The savings are becoming more significant each year as the cost of the electronic technology is reduced. For example, fast semiconductor memory is a tenth as expensive now as it was in 1975; the cost will drop by another factor of 10 by 1995. The result has been to bring into the individual consumer's price range information-handling capabilities that only a few years ago called for very expensive equipment.

As the market for mechanized work stations expands, more money is invested in research and development for communications, electronics, software, office-mechanization systems and the like. The time span between the development, introduction and obsolescence of a product becomes shorter. Each year brings a new generation of semiconductor devices; each generation makes possible a new set of applications. The dramatic improvement in products in turn builds demand for them and strengthens the trend toward office mechanization.

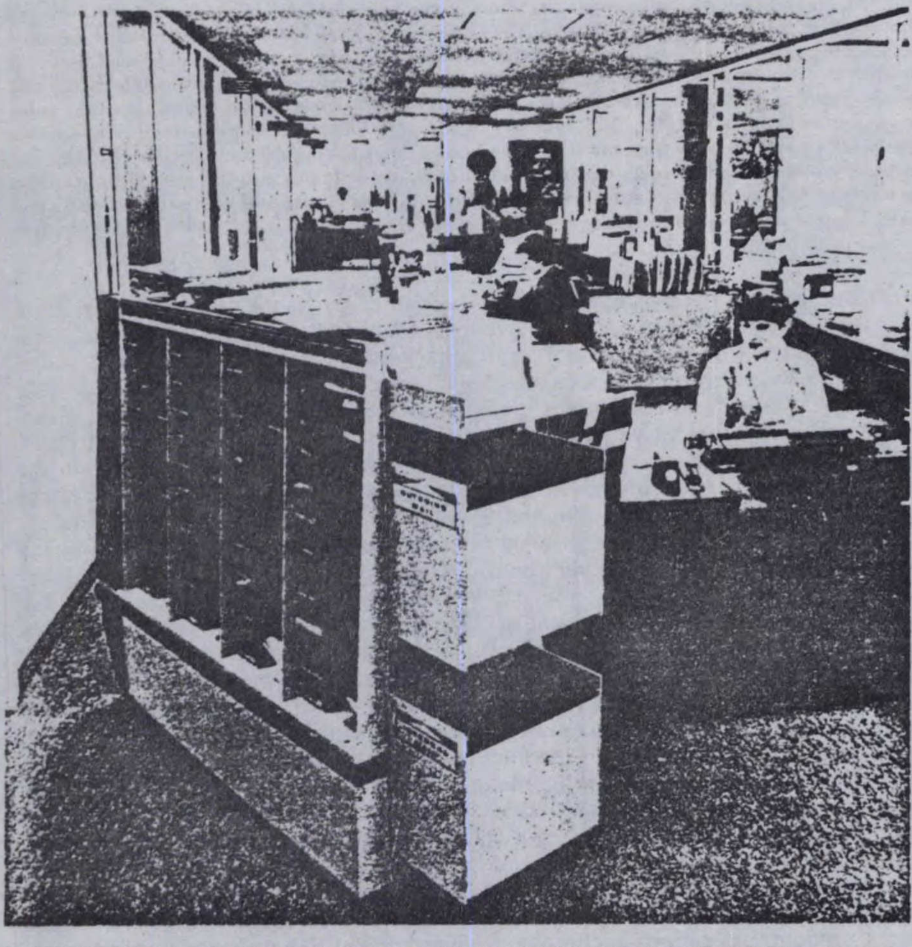
Whether a company's business is in farming, mining, manufacturing, transportation or retailing, its management, marketing, distribution and other operating controls are basically office-centered, information-handling activities. As the number of blue-collar workers decreases, the proportion of white-collar workers even in manufacturing organizations continues to increase. In virtually all commercial enterprises one finds executives, managers, clerks and secretaries; in most organizations there are also more specialized information workers, such as engineers and scientists, attorneys, salesmen, librarians, computer programmers and word processors. These people constitute the human-capital resources that can make an information-intensive economy viable.

Yet a tendency to think of white-collar workers in offices as support personnel, outside the economic mainstream, has tended to inhibit the transformation of office work. Physical activities that produce food, minerals and manufactured goods have been regarded as the only truly productive ones, whereas the handling of information has been considered necessary but essentially nonproductive. This way of looking at things (which may have been appropriate in an industrial society) persists today, even in the minds of economists who call for the "reindustrialization of America." It deeply affects the thinking of corporate management.

Even though most work in American society is information work and most such work is done in offices, the benefits of an increase in the productivity of office workers are not always within the field of view of managers. For those who retain a preindustrial view of office organization the very concept of productivity seems irrelevant or inappropriate in the context of offices or information work. Those who have an industrial-office orientation tend to focus on laborsaving measurements; the installation of new technology and a system for exploiting it is evaluated only in the context of cutting visible office costs.

It is in offices that the basic decisions are made that determine the cost-effectiveness of an entire organization. The office is the place where the timeliness of a decision or of a response can have immense consequences. If the office is ineffective, the organization must be ineffective. As it happens, moreover, a high degree of mechanization of the kind described in this article is much less expensive in the office than analogous mechanization is in the factory or on the farm.

The mechanization of office work is an essential element of the transformation of American society to one in which information work is the chief economic activity. If new information technology is properly employed, it can enable organizations to attain the following objectives: a reduction of information "float," that is, a decrease in the delay and uncertainty occasioned by the inaccessibility of information that is being typed, is in the mail, has been misfiled or is simply in an office that is closed for the weekend; the elimination of redundant work and unnecessary tasks such as retyping and laborious manual filing and retrieval; better utilization of human resources for tasks that require judgment, initiative and rapid communication; faster, better decision making that takes into account multiple, complex factors, and full exploitation of the virtual office through expansion of the workplace in space and time.



MAILMOBILE, a driverless battery-powered delivery vehicle made by Bell & Howell, mechanizes intraoffice deliveries. Here it is negotiating a curve as it makes its way through the research department of Merrill Lynch and Company. The vehicle follows a chemical pathway, which is easily applied and modified to trace any route from the mail room through the office and back to the mail room. An emitter of ultraviolet radiation under the vehicle makes the chemical fluoresce; an optical sensor detects the fluorescent path. The Mailmobile moves at about one and a half feet per second (one mile per hour), beeping and flashing blue headlights. It stops at pickup and delivery sites designated by a coded pattern in the chemical pathway. Bumpers stop the vehicle on contact with a person or another obstacle. An "intelligent" version is being introduced that can be directed to choose among alternate paths or to board an elevator.

The awkward truth about productivity

At last managers are admitting, 'We have met the enemy and they is us'

Arnold S. Judson

Only recently have managers in the private sector begun to acknowledge openly that much of the responsibility for their companies' poor productivity lies at their own door. True, they have not ignored the issue of productivity improvement, as some of their critics claim; they have, instead, defined their efforts too narrowly, administered them in too disjointed a fashion, controlled them with too short a time horizon in mind, organized them with too little attention to how well they fit with overall business strategy, and implemented them without the wholehearted involvement of top management. Turning these lackluster efforts into successful ones requires no magic formula or obscure boardroom ritual. All it takes is the determination – and the skill – to manage productivity as a part of corporate operations that is no less critical to market success than are the other major functions.

Mr. Judson is chairman of Gray-Judson, a Boston-based consulting firm that provides counsel on strategic management. The focus of his consulting work in the USA, Britain, and the Middle East has – during the past two decades – been on the productivity of organizations.

- Management ineffectiveness is by far the single greatest cause of declining productivity in the United States.
- Most companies' efforts to improve productivity are misdirected and uncoordinated.
- Tax disincentives, the decline of the work ethic, problems with government regulation, obsolete plant and equipment, insufficient R&D, and poor labor relations all have little to do with industry's faltering productivity.

These conclusions, which emerge from a recent study of 236 top-level executives representing a cross-section of 195 U.S. industrial companies, contradict much of what is generally believed about the productivity performance of U.S. industry. (See the ruled insert on p. 97 for details of this study.) Of late that performance has been anything but spectacular: 52% of the companies studied reported annual gains of less than 5%; another 19% reported gains of 5% to 10%; only 3% had gains exceeding 10%; and 25% did not even know what their productivity performance had been. Worse still, because roughly half the companies did not correct their information for inflation, these figures do not show that 32% actually experienced a decline in productivity.

The most troubling results of the study are summarized in *Exhibits I* and *II*. What emerges from these data is a disheartening picture of how knowledgeable American managers regard the current status of efforts to improve productivity. In their view:

- The scope of most productivity improvement efforts is too narrow. Their focus is pri-

Author's note: I would like to express my appreciation to my colleague and partner Daniel H. Gray, whose many conversations with me about productivity during the course of our 20 years' association helped to shape concepts presented in this article.

Exhibit I

Causes of success or disappointment in improving productivity

Capital investment in plant, equipment, and process	72%
Top management commitment and involvement	61
Good financial controls and information systems	45
Good employee relations	38
Good communications	35
Competent middle managers in all departments	34
Effective industrial and manufacturing engineering staff	29
Strong, dedicated first-line supervisors	29
Coordination and cooperation among organizational functions and departments	27
Training and development of supervisors and managers	23
Engineering sensitivity to manufacturing implications of product and process designs	22
A comprehensive, systematic companywide approach to productivity improvement	22
Training of the work force	20
A loyal, skilled work force	18
Incentives and rewards	14
Cooperative union leadership	6

A piecemeal, unplanned approach to improving productivity	66%
Inadequate coordination among departments or functional areas (excessive functional or departmental autonomy)	42
Insufficient investment in management and supervisory training and development	41
Lukewarm commitment and involvement by top management	40
Insufficient awareness by engineering of the manufacturing implications of product and process designs	39
Weaknesses in industrial and manufacturing engineering	39
Weak first-line supervision	35
Poor communication	32
Insufficient investment in work-force training	32
Poor financial control and information systems	24
Weak middle managers	21
Decline of the work ethic	20
Lack of incentives or appropriate rewards (or disincentives)	20
Insufficient capital for improved plant and equipment	17
Poor employee relations	9
Poor relationship with union leadership	8

marily – and often exclusively – on cost savings in one or another part of a company (usually in manufacturing), not even throughout the company as a whole. Most common is a concern for the effectiveness of direct labor in manufacturing; rare, by contrast, is a concern for how the various functions interact and affect one another.

☐ Almost all such efforts are disjointed and address the symptoms rather than the causes of low productivity. The vast majority of productivity programs consist of a series of separate, uncoordinated initiatives, which are directed at "wherever we're hurting" at the moment – reducing scrap and rework, for example, or reducing absenteeism and accidents, tightening standards, or correcting the abuse of work breaks and lunch periods.

☐ Most efforts have short time horizons and are geared toward quick fixes. More than 75% of the executives queried noted that their companies' programs had a time horizon of less than a year. Only 22% claimed time horizons of from one to three years.

☐ Few companies (about 33%) base their productivity efforts on explicit plans that are consistent with and support overall business plans.

☐ The involvement of top management in these efforts has been lukewarm. The business press may blame industry's poor record of productivity improvement on unresponsive government, obdurate unions, or lagging capital investment. However, managers (as these findings indicate) place the responsibility elsewhere – most often, on themselves.

Missed opportunities

In company after company, managers are ignoring major opportunities for productivity improvement. Manufacturers often do not, for example, make the best use of indirect labor or salaried staff

–that growing cadre of office workers and "knowledge workers." Nor do they pay much attention to the critical interactions of such various functions as product engineering with manufacturing or marketing with manufacturing. For that matter, they do not make effective, coordinated use of organizational resources in planning, finance, control, and personnel. The gains to be realized from such coordination commonly outdistance those achievable within each function.

Consider, for example, the experience of a division of one of America's largest industrial producers of medium- and large-sized electrical equipment. A young, sophisticated management team had decided to improve manufacturing productivity by mechanizing certain labor-intensive operations, by introducing CAD/CAM into engineering-related functions, by reducing overall materials costs, and by upgrading their quality assurance programs. Taken together, these efforts had, over three years, resulted in a productivity improvement of more than 17%.

The management team was slow to realize, however, that the formal plans for its two businesses required different sets of manufacturing priorities. Although the large-equipment business emphasized quality and the other emphasized cost, the division's production system had long been geared toward quality and fast response to customer-required changes in engineering design. When management finally recognized the separate needs of its two product lines, it was able to identify several high-leverage opportunities to enhance productivity.

First, because engineers usually developed product designs with little concern for how they were to be manufactured, they paid scant attention to manufacturing costs, materials and equipment utilization, or the products of competitors. By involving production managers at the earliest stages of the engineering process, the division assured itself of designs that were comparatively easy and inexpensive to make. Also, the division agreed to coordinate efforts between engineering and manufacturing so as to derive maximum benefit from newly acquired CAD/CAM technology.

Second, because the unit's domestic business was cyclical and employees feared they would lose their jobs if they improved productivity, a limited attempt to involve employees in a quality-of-work-life strategy failed. At last, marketing and manufacturing agreed to work together to develop export opportunities. This, in turn, paved the way for a joint strategy to control sales growth, capitalize on economies of scale by scheduling longer production runs, and stabilize employment. The quality-of-work-life strategy was then revived–but with a broader scope and better employment safeguards.

Finally, management discovered that several staff functions might contribute greatly to the productivity effort. Employee relations, for example, could provide training to support CAD/CAM's introduction, could help broaden production operators' skills and knowledge, and could enhance the perspective of mid-level managers with respect to functions other than their own. Overall, the organizationwide approach plus this follow-up yielded gains almost double those achieved in the past.

Revamped thinking

What made this division's efforts successful was its managers' ability to redefine and broaden their understanding of what productivity meant. Where once they viewed it as a matter only of reducing direct-labor costs in manufacturing, they came to see that it included all costs, as well as functional integration and the quality of operations. They also enlisted the joint, systematic participation of both operating managers and staff in analyzing the causes of poor productivity, identifying the major opportunities for betterment, making crucial trade-offs, and formulating action plans.

From the outset, these plans were explicitly designed with the task of implementation in mind. A credible overall productivity effort and sincere commitment from affected managers are the keys to successful implementation. Credibility, in turn, stems from a belief that the problem has been carefully and comprehensively studied and that the major levers of change have all been identified. It comes as well from the direct involvement of managers working closely together to draw up explicit–and realistic–action plans.

In a similar fashion, commitment derives from an understanding of what must be done and of how and why it is to be done, in what sequence, under whose responsibility, and by what target date. Such understanding breeds a genuine feeling of ownership in the plan; and when managers believe that a plan is at least partly theirs, they are likely to devote much energy to realizing it.

A move toward integration

The managers studied also agreed strongly that the poor results of most plans stemmed from the disjointed nature of corporate productivity programs, their short-term horizons, and their attention to symptoms rather than underlying causes. A

Exhibit II **The single most important reason for America's declining productivity**

Reason	Percent selected
Management's ineffectiveness in addressing this problem within separate organizations	30%
Management's excessive concern with short-term results	30
Decline in the work ethic	8
An adversary relationship between business and government	7
Insufficient participation by the work force in decisions affecting production	7
Inadequate tax incentives for saving and investment	6
Government regulation	5
Obsolete plant and equipment	5
Labor unions	3
Lack of effective incentives (workers' reward systems)	1
Unfair foreign competition	0
Insufficient emphasis on production in business schools	0
Other	6

desire for quick, visible results often directs efforts at such accessible targets as lower-than-standard levels of output or high levels of absenteeism, scrap, rework, and in-process and final-product defects. These efforts usually lack credibility with middle and low-echelon managers, for these "hands on" people know that the root of the problem lies elsewhere and that quick fixes of easy targets are not real solutions.

Short time horizons also discourage a much-needed interfunctional or interdepartmental approach. Just because the symptoms of poor productivity are, as a rule, most visible in manufacturing, it does not follow that that is where all the important causes reside.

Only when a company's productivity effort encompasses the entire organization and all of its systems and procedures does it represent a genuinely strategic approach to productivity management. Take, for instance, the case of a large manufacturer of a complex, high-technology, and high-volume consumer product. Its traditional assembly-line approach to production – based on low-skill, highly specialized, repetitive jobs – fit well with the seasonal nature of consumer demand and with the need of the process to be responsive to fluctuations in volume. For this "fit," however, the company paid a high price.

Most employees found little satisfaction in their entry-level jobs and kept at them on average less than six months. This high rate of turnover, combined with low morale and chronic absenteeism, considerably boosted the number – and expense – of production defects. An extensive repair effort, which called on the support of quality engineers, materials handlers, and schedulers, did salvage most of these defects; but at any one time almost a third of the units were being recycled and reworked.

Although past efforts to raise quality and productivity had achieved some incremental improvements in defects and costs, the levels of rework, absenteeism, and employee turnover remained stubbornly high. Neither micro-motion studies to set work standards nor training programs for assemblers and first-line supervisors nor even the better inspection of incoming parts made any lasting difference. Only when the vice president for operations decided to try an integrated quality-of-work-life approach did things change.

A quality-of-work council, consisting of managerial and employee volunteers in equal numbers, established an agenda of some 20 conditions or practices that needed changing and, using the agenda as a guide, drew up in detail several alternative plans for manufacturing the product. Each of these options included detailed job descriptions plus a statement of desired workplace layouts, equipment needs, supporting-role and system requirements, and recommended work procedures and processes. Not surprisingly, all of the options rejected the company's past reliance on assembly-line production and extensive job specialization. Instead, the council leaned toward small, autonomous, and partly self-managed work groups. These groups were to be responsible not only for making, inspecting, and repairing the product but also for assuming in varying degrees the functions usually provided by materials management, quality engineering, manufacturing engineering, training, and instrument maintenance. These groups were also to assume some of the activities then being handled by lower-level supervisors.

Next, the council established a pilot operation to test and evaluate these new work-design options. Two of them proved especially successful and, when put in place after some two years of effort, achieved overall productivity gains of from 40% to 50%. About half this improvement came directly from greater efficiency in assembly; the other half, from a major reduction in the overhead services (the technical experts, inspectors, and supervisors) needed to support production. Management then applied a third of the gross savings to upgrading the job ratings and the pay of production workers, an increase justified by the expanded scope and increased demands of the new job arrangements.

True, a strategic approach to productivity takes time, resources, and a disciplined willingness

How the survey was done

Almost all of the 195 companies participating in the study, which was conducted between June 1980 and May 1982, are manufacturers; as a group, they represent some 38 different industries.

Of the companies surveyed, 37% were *Fortune* "500" companies, 18% had sales exceeding $110 million, 15% had sales between $50 million and $110 million, and 30% were businesses with sales from $10 million to $50 million.

The 236 people who responded were all members of senior management—mostly chief executive officers, chief operating officers, vice presidents of all sorts, and general managers.

to look carefully at all aspects of a company's operations–line and staff alike. But it is the only approach that offers genuine hope of substantial and lasting gains.

A failure of sponsorship

Finally, our sample of managers believed that top management commitment to productivity improvement efforts has been low. In fact, many top managers, consistent with their narrow definition of productivity, excused their lack of direct involvement by treating the responsibility as a task to be delegated to plant management. This attitude of benign neglect is not lost on their subordinates. Before spending energy and attention on such tasks, lower-level managers inevitably ask, "Is top management really behind us, resources and all?" and "Is top management really serious about this?" When the answers are no, the whole organization suffers.

If top management limits its involvement merely to the articulation of goals and the exhortation of subordinates, nothing much will happen. It must, instead, assume the role of sponsor for the entire productivity effort. Sponsorship does not mean direct involvement in the identification of particular areas for productivity improvement or in the design and implementation of remedial programs. It means, rather, definition of the broad scope and necessary order of magnitude of the effort, selection of the operating managers to implement it, provision to those managers of necessary strategic guidelines, and assurance of adequate and ongoing support.

The sponsor's statement of guidelines should inform each head of an operating unit that a productivity strategy for the unit is to be drawn up–together with a forecast of needed resources and of results expected, a rationale that supports the choice of options, and a detailed set of action programs to implement them. Further, the statement should caution each unit head to make certain that the strategy selected complements the relevant business plan and identifies all key issues requiring resolution by the sponsor. Finally, the statement should note areas deserving special attention by unit managers, particular resource constraints to be kept in mind, and assumptions the units should consider in their planning.

After the operating managers submit their proposals, the sponsor must review each submission, seeking answers to several key questions: (1) Does the proposal fit the relevant business plan? (2) How feasible is it in light of the unit's strengths and weaknesses? (3) How credible is it as a blueprint for implementation? (4) What is the probability of success? (5) How accurate is the assessment of risks? (6) Have all central issues been identified?

Only then should the sponsor consider whether the company has enough resources to support all the proposed strategies and, if not, what trade-offs or modifications need to be made.

A new point of view

To manage this kind of process well, sponsors must have a particular point of view. They must regard productivity as the achievement–or the failure–of an entire organization. They must believe that effective productivity improvement requires a set of long-term investment decisions with attendant entrepreneurial risks. Before making final decisions, they must encourage among all those managers with knowledge of the opportunities for, and barriers to, enhancing productivity the free exchange of opinions in vigorous, open debate. They must treat implementation as a crucial issue from the outset. And they must honestly see the process of making strategic choices as an opportunity to involve directly, and to ensure the support of, many of the managers responsible for implementation.

Anything less–especially in today's competitive environment–is an abdication of responsibility. ∇

New worlds of computer-mediated work

Information technology can radically alter the ways employees approach their tasks and offer managers a chance to develop new approaches to work organization

Shoshana Zuboff

When managers make changes in the ways employees perform their work it's only natural for the employees to resist. Managers themselves are famous for the not-invented-here syndrome that is a disguised way of resisting change. It's not surprising that when they hear about resistance to working with the new information technology managers dismiss it as normal and to be expected. The author of this article maintains that managers should heed the resistance, however, because it is telling them something about the quality of the changes that are taking place. Computer-mediated work is more abstract and can demand new conceptual skills while de-emphasizing the importance of direct experience. Information technology can potentially depersonalize supervision, alter social communities, and often means that technology absorbs much of the judgment that routine jobs used to entail. The author suggests ways that managers can use the new technology as an opportunity to re-envision job responsibilities and develop new approaches to the problems of supervision.

Ms. Zuboff is assistant professor of organizational behavior and human resource management at the Harvard Business School. She has consulted with numerous companies on the effects of the computer at work. Her present research is funded by NIMH The Center for Work and Mental Health, with additional support from the Division of Research at the Harvard Business School.

Illustrations by Robert Pryor.

One day, in the 1860s, the owner of a textile mill in Lowell, Massachusetts posted a new set of work rules. In the morning, all weavers were to enter the plant at the same time, after which the factory gates would be locked until the close of the work day. By today's standards this demand that they arrive at the same time seems benign. Today's workers take for granted both the division of the day into hours of work and nonwork and the notion that everyone should abide by a similar schedule. But, in the 1860s, the weavers were outraged by the idea that an employer had the right to dictate the hours of labor. They said it was a "system of slavery," and went on strike.

Eventually, the owner left the factory gates open and withdrew his demands. Several years later, the mill owner again insisted on collective work hours. As the older form of work organization was disappearing from other plants as well, the weavers could no longer protest.

In general, industrialization presented people with a fundamental challenge to the way they had thought about behavior at work. The employer's desire to exploit the steam engine as a centralized source of power, coupled with the drive to closely supervise workers and increase the pace of production, resulted in a greater degree of collectivization and synchronization in the workplace. Employers imposed an exact discipline on workers that required them to use their bodies in specified ways in relation to increasingly complex forms of equipment. By the early 1900s, "scientific management" had given supervisors a systematic way to measure and control the worker's body.

Although most workers have accepted the work behavior that industrialization fashioned, the issues behind the New England weavers' resistance lie at the heart of modern labor-management relations. Using collective bargaining, later generations of workers have developed elaborate grievance procedures and work rules that carefully limit an employer's right to control a worker's body.

New forms of technology inevitably change the ways people are mobilized to work as well as the kinds of skills and behavior that are critical for productivity. These changes are rarely born without pain and conflict – nor do they emerge exactly as planners envision them. Instead, new conceptions of work organization and behavior emerge from an interaction between the demands of a new technology, its social organization, and the responses of the men and women who must work with the new technological systems.

In this regard, the weavers' example is doubly instructive. First, it illustrates that during a period of technological transition people are most likely to be aware of and articulate about the quality of the change they are facing. When people feel that the demands a new technology makes on them conflict with their expectations about the workplace, they are likely, during the initial stage of adaptation, to resist. Many managers maintain that employees are simply denying change when they cling to familiar patterns and complain as these forms of sustenance are threatened. But resistance can also reveal an eloquent appraisal of the *quality* of change – a subtle commentary that goes beyond a stubborn attachment to custom.

Second, the weavers' example shows that as a major technological transition recedes into the past, and with it the sense of psychological crisis, older sensibilities tend to become subsumed or repressed. However, original sources of resistance, if they are not properly resolved, can continue to influence the management-labor agenda for many years, even though employees may accommodate the demands of a new technology.

Business is now witnessing a period of technological change that shares some important features with the first industrial revolution. Information technology is rapidly reorganizing the kind of work people do across industries and organizational strata. It is affecting clerical workers through the automation of high-volume back-office operations as well as with word processing and electronic mail. Managers are more frequently making use of computer conferencing, decision-support systems, sophisticated modeling procedures, and new on-line management information systems. Blue-collar workers are increasingly required to interact with computer technology in order to monitor and control a variety of manufacturing and continuous-process operations. During the past year, business people bought one million data terminals, worth $2.6 billion, to supplement the four million terminals already in use. The market for intelligent terminals is expected to grow 25% annually during the coming decade.

This increased use of information technology is altering the technological infrastructure of the workplace. More and more, production in office and factory depends on the computer and large-scale information systems that can control increasingly complex sets of data. And just as with industrial technology, people who are required to use information systems often resist their introduction. When managers allow employee discontent with new computer-based technology a voice, they can learn a great deal about the more subtle effects of this technology and the issues that are likely to challenge their practices in the coming decade.

During the last few years I interviewed approximately 200 employees, supervisors, professionals, and managers from several different organizations in three countries to discover how people at distinct organizational levels respond to their work when it has been fundamentally reorganized by information technology. (See the ruled insert on page 146 for a description of the organizations and their information systems.) In this article, I outline the principal themes that emerged repeatedly from my interviews and observations, both as they pertain to employees' experiences of information systems and as observable, often unintended, consequences for the organization. Finally, I identify some of the implications of these findings for human resource management policies.

Management policies toward automation

In many ways, management policies can determine the effectiveness of automation and the quality of the workplace culture that emerges. In this regard, my discussions with employees and managers reveal two primary concerns.

Substitution & deskilling of labor

The purpose of the intelligent technology at the core of a computer system is to substitute algorithms or decision rules for individual judgments. This substitution makes it possible to formalize the skills and know-how intrinsic to a job and integrate them into a computer program. As decision rules become more explicit, the more they are subject to planning, and the less they require a person to make a decision at each stage of execution. For some jobs the word "decision" no longer implies an act of human judgment, but an information processing activity that occurs according to rules embedded in a computer program.

At present, most programmed decision making has been limited to the most routine jobs in an organization such as high-volume operations where tasks can be simplified and rationalized to maximize outputs and minimize skill requirements. For example, partly by limiting a collector's discretion regarding how or in what order he or she should work on an account, an automated collection system makes it possible to increase production goals and reduce the time spent on each account.

Thus for that activity the key to revenue generation becomes volume instead of collection skills. Collection managers I interviewed believe that the system enables them to recoup more funds while reducing their dependence on skilled collectors. One collection manager described the value of the system:

"It gives us a tighter lock on the collector, and we can hire less skilled people. But there's a real loss to the job of skills and know-how. You are being told what to do by the machine."

But job deskilling is not exclusive to the most routine jobs in the organization. A decision-support system installed for a bank's 20 credit analysts was supposed to free them from the most mechanical and boring aspects of the job. Six months after the system was in place, not a single analyst had used it. As one analyst explained it, "I think, then I write down my calculations directly. I know the company and the problem. With this system, I am supposed to type into the machine and let it think. Why should I let it do my thinking for me?"

Automation of managerial assumptions

Information systems can embody management's assumptions and values about its employees, especially about their commitment and motivation. The automated collection system provides an example of how this happens.

Bill Smith had managed collection activities for 30 years, and management considered his perspective invaluable. In creating the system, designers spent long hours debriefing Smith, and he helped them make many important design decisions. Senior managers explain key design decisions by saying: "We tried to build Bill Smith's brain into the computer. If we did not build it into the system, we might lose to the competition."

When I talked to Bill Smith, some of the reasons the system eliminated most discretion from the job became clear. As Smith put it:

"I like to see people work. I'm a good worker. I don't like to see people take time off. I don't do it."

The depth of memory and extent of communications that computer systems are capable o mean that managerial biases can surround the employee as never before. The cost of Smith's managerial assumptions in the collections operations system was high. A year after the system was in place, turnover had reached almost 100%, and the corporate personnel and employee counseling offices were swampec with complaints from replacements. The new and less-educated collectors presented a different set of problems for management and training. Even with the new staff, turnover remained about three times higher than in the rest of the back-office organization.

Computer mediation of work

As the Bill Smith example illustrates, managerial assumptions can easily get embedded in information systems. But what impact do the new systems have on the organization of work and what actually happens to the people who interact with them?

Work becomes abstract

When information technology reorganizes a job, it fundamentally alters the individual's relation to the task. I call the new relationship "computer mediated." Usually, this means that a person accomplishes a task through the medium of the information system, rather than through direct physical contact with the object of the task.

Computer mediation can be contrasted to other forms of task relationships in terms of the way in which one *knows* about the object of the task. The potter who turns a pot with his or her own hands has direct experience of the task's object through continual series of sights and tactile sensations. These sensations form the basis for moment-by-moment judgments regarding the success of the process and any alterations that the potter should make. Machines, such as a press or a welding torch, usually remove the worker as the direct source of energy for the labor process, but leave the task's object within sensuous range. Those who work with paper and pencil usually feel "in touch" with the objects of their tasks through the activity of writing and because they are the sources of what they write.

With computer-mediated work, employees get feedback about the task object only as symbols through the medium of the information system. Very often, from the point of view of the worker, the object of the task seems to have disappeared "behind the screen" and into the information system.

The distinction in feedback is what separates the linotype machine operator from the clerical worker who inputs cold type, the engineer who works with computer-aided design from one who directly handles materials, the continuous process operator who reads information from a visual display unit from one who actually checks vat levels, and even the bill collector who works with an on-line, real-time system from a predecessor who handled accounts cards. The distinctiveness of computer-mediated work becomes more clear when one contrasts it against the classic image of work from the nineteenth century in which labor was considered to be the transformation of nature by human muscle. Computer-mediated work is the electronic manipulation of symbols. Instead of a sensual activity, it is an abstract one.

Many employees I spoke to reported feeling frustrated because in losing a direct experience of their task it becomes more difficult to exercise judgment over it. In routine jobs, judgment often becomes lodged in the system itself. As one bill collector said:

"In our old system, come the end of the month, you knew what you were faced with. With the automated system, you don't know how to get in there to get certain accounts out. You have to work the way the system wants you to."

People in even more complex jobs can also lose direct experience of their tasks. The comptroller of a bank that was introducing information systems to a variety of functions commented:

"People become more technical and sophisticated, but they have an inferior understanding of the banking business. New people become like systems people and can program instructions that don't necessarily reflect the spirit of the operation."

The auditor at one bank is working with a new information system that frees him from traveling to regional branches. The branches feed financial data directly into the information system that he can access in real time. He described his job this way:

"The job of auditing is very different now. More imagination is required. I am receiving data online. I don't go to the branches if I don't want to. I don't see any books. What do I audit in this situation? I always have to be thinking about what is in the system. I may be auditing, but it doesn't feel like it."

The auditor now has access to a new level of complexity in his data. He has the possibility

The research sites

[illegible] in this article are principally [illegible] kinds of organizations—banking [illegible]. Each of these applications [illegible] six months to one year before [illegible]

[illegible] information systems in the bank included: [illegible] system in the credit analysis department [illegible] to perform "routine" calculations for [illegible] information systems for account officers that [illegible] and analyses of account activity in [illegible] business criteria of a company [illegible] converted front-end processes [illegible] letter of credit, and [illegible] on-line real-time basis, thus [illegible] office employees and [illegible]

[illegible] was the automation of [illegible] in the back office of a large discount [illegible] chain [illegible] collectors functioned as [illegible] individual tray of accounts [illegible] automated system pooled all accounts [illegible] queued in order of priority and [illegible] among collectors [illegible]

[illegible] organizations [illegible] and communicated [illegible] use of computer conferencing and [illegible]

of comparing branches according to criteria of his choice and searching out new relationships in the data. But in order to do this, he must now develop a theory of the auditing process. He needs to have a conceptual framework that can guide him through the mass of available information. Theoretical insight and imagination will be the keys to his effectiveness on the job.

By creating a medium of work where imagination instead of experience-based judgment is important, information technology challenges old procedures. Judging a given task in the light of experience thus becomes less important than imagining how the task can be reorganized based on new technical capabilities. In the banking industry, for example, planners are not automating the old, but inventing the new.

While working through information systems seems to require a more challenging form of mental effort, it can also induce feelings of frustration and loss of control.

A collections supervisor described the difference between the manual and computer systems:

"If you work with a manual system and you want to see an account on a given day, you have a paper file and you simply go to that particular section and pull out the file. When you're on the computer system, in a sense all your accounts are kind of floating around in space. You can't get your hands on them."

Some people cope with this frustration by creating physical analogues for their tasks. In one bank branch, an on-line system had been installed to update information on current accounts. Instead of making out tickets that would be sent to a data center for overnight keypunching, operators enter data directly into terminals; the system continuously maintains account information. Despite senior management's efforts to persuade them to change, the branch manager and his staff continued to fill out the tickets. When asked why, they first mentioned the need for a backup system. The real reason came out when the branch manager made the following comment: "You need something you can put your hands on. How else can we be sure of what we are doing?"

People are accustomed to thinking of jobs that require employees to use their brains as the most challenging and rewarding. But instead, the computer mediation of simple jobs can create tasks that are routine and unchallenging, while demanding focused attention and abstract comprehension. Nevertheless, the human brain is organized for action. Abstract work on a mass scale seems likely to create conditions that are peculiar if not stressful to many people. While it does seem that those who shift from conventional procedures to computer-mediated work feel this stress most acutely, it's impossible to forecast what adaptation to the abstraction of work will do to people over the long term.

Social interaction is affected

Doubtless, once information technology reorganizes a set of jobs, new patterns of communication and interaction become possible. In time, these patterns are likely to alter the social structure of an organization.

When resources are centered in the information system, the terminal itself can become employees' primary focus of interaction. This focus can lead people to feel isolated in an impersonal situation. For example, because functional operations in the back office of one bank have been reorganized, a clerical worker can complete an entire operation at his or her "professional" work station, rather than repeat a single procedure of it before passing the item on to someone else. Although employees I talked to were split in their attitudes toward the new back-office system, most of them agreed that it created an uncomfortable isolation. Because they had few remaining reasons to interact with co-workers, the local social network was fragmented.

Decades of research have established the importance of social communities in the workplace and the lengths to which people will go to establish and maintain them. Since people will not easily give up the pleasures of the workplace community, they tend to see themselves at odds with the new technology that transforms the quality of work life. The comments of one employee illustrate this point:

"I never thought I would feel this way, but I really do not like the computer. If a person makes a mistake, dealing with the computer to try and get that mistake corrected is so much red tape. And it's just taken a lot of feeling out of it. You should have people working with people because they are going to give you what you want, and you're going to get a better job all around."

In a very different kind of application, professionals and managers in the R&D organization of a large consumer goods company find the range of their interaction greatly extended with computer conferencing. While there is some evidence of reduced face-to-face interaction, the technology makes it relatively easy to initiate dialogues and form coalitions with people in other parts of the corporation. Clearly, information technology can offset social life in a variety of ways. It is important to realize, however, that this technology has powerful consequences for the structure and function of communication and social behavior in an organization.

New possibilities for supervision & control

The dream of the industrial engineer to create a perfectly timed and rationalized set of activities has never been perfectly realized. Because face-to-face supervision can be carried on only on a partial basis, employees usually find ways to pace their own activities to meet standards at a reasonable rate. Thus, traditionally, supervision depended on the quality of the relationship between supervisor and worker. If the relationship is a positive one, employees are likely to produce quality work without constant monitoring. If the relationship is adversarial, the monitoring will be continual.

But because work accomplished through the medium of video terminals or other intelligent equipment can be recorded on a second-by-second basis, the industrial engineer's presence can be built into all real-time activities. With immediate access to how much employees are producing through printouts or other visual displays, supervisors and managers can increase surveillance without depending on face-to-face supervision. Thus the interpersonal relationship can become less important to supervision than access to information on the quality and quantity of employee output. One bank supervisor described this new capability:

"Instead of going to someone's desk and physically pulling out files, you have the ability to review peoples' work without their knowledge. So I think it keeps them on their toes."

Another variant of remote supervision involves controls that are automatically built into systems operations, as in the collections system described earlier. These rules are substitutes for a certain amount of supervisory effort. Because the system determines what accounts the collector should work on and in what order, a supervisor does not have to monitor collectors' judgments on these issues. Managers also see automatic control as the organization's defense against the potentially massive pollution of data that can occur through access by many people to an on-line real-time system.

Remote supervision, automatic control, and greater access to subordinates' information all become possible with computer-mediated work. In some cases, these capabilities are an explicit objective, but too often management employs them without sufficiently considering the potential human and organizational consequences.

With remote supervision, many employees limit their own risk-taking behavior, such as spotting an error in the data and correcting it, developing a more effective approach to the work than the procedures established by the information system, or trying to achieve quality at the expense of keeping up with new production standards.

One reason the initiative to design a custom-made approach to a particular task has become too risky is that many people have difficulty articulating why their approach might be superior to other alternatives. Usually, management has developed a clearly articulated model of the particular task in order to automate it, and if employees cannot identify their own models with equal clarity, they have little hope of having their views legitimated.

Another reason for decreased employee initiative is that the more an information system can control the details of the job, the less even relatively trivial risk-taking opportunities are available. Finally, the monitoring capabilities increase the likelihood that a supervisor will notice a deviation from standard practice. As one bank employee noted:

"Sometimes I have a gut feeling I would rather do something another way. But, because it is all going to be in the computer, it changes your mind. If somebody wouldn't listen to the reason why you did it that way, well, it could cause you quite a problem."

Another frequent response to the new relationships of supervision and control involves perceptions of authority in the workplace. Employees can tend to see technology less as an instrument of authority than as a source of it. For instance, one group of bank employees with an especially easygoing manager described the work pace on their computer-mediated jobs as hard-driving, intense, and at times unfair, but thought the manager was friendly, relaxed, and fair-minded.

One collector told about the difference in her attitudes toward her work under the manual system and under the automated system:

"When I worked with the account cards, I knew how to handle my responsibilities. I felt, 'Hey! I can handle this!' Now I come in every day with a defeatist attitude, because I'm dealing with the tube every day. I can't beat it. People like to feel not that they are necessarily ahead of the game, but that they have a chance. With the tube I don't have a chance."

While this employee knows that her manager is the actual authority in the office, and that he is in turn accountable to other managers, she has an undeniable feeling that the system, too, is a kind of authority. It is the system she must fight, and, if she wins, it is the system she vanquishes.

In the Volvo plant in Kalmar, Sweden, a computer system was installed to monitor assembly operations.[1] A feedback device was programmed to flash a red light signalling a quality control problem. The workers protested against the device, insisting that the supervisory function be returned to a foreman. They preferred to answer to a human being with whom they could negotiate, argue, and explain rather than to a computer whose only means of "communication" was unilateral. In effect, they refused to allow the computer to become, at least in this limited situation, an authority. Yet clearly, the issue would never have arisen in the first place were the technology not capable of absorbing the characteristics of authority.

Finally, these capacities of information systems can do much to alter the relationships among managers themselves. A division or plant manager can often leverage a certain amount of independence by maintaining control of key information. Though a manager might have to present the data in monthly or quarterly reports, he or she has some control over the amount and format. With information technology, however, senior managers in corporate headquarters increasingly have access to real-time systems that display the day-to-day figures of distinct parts of the company's business. For instance, a division vice president can be linked to the information system that transmits raw production data from a processing plant in another state. Such data can provide the vice president with a view of the plant that only the plant manager or mid-level managers in the operation previously had.

This new access raises several questions for a corporation. First, some policy decisions must be confronted that address the kind of information appropriate to each level of management. Top managers can quickly find themselves inundated with raw data that they do not have the time to understand. It also creates a tendency for top managers to focus on the past and present when they should be planning the future.

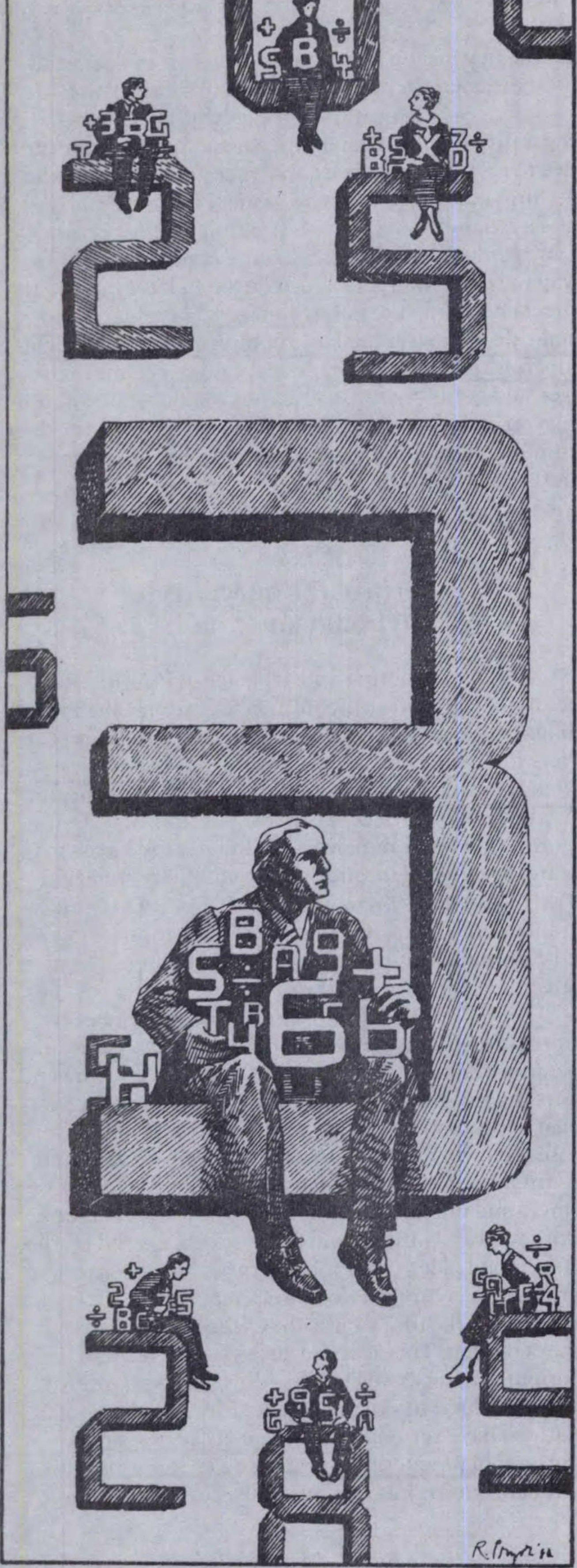
It would seem that this new access capability would expand top management's opportunities to monitor and direct and, therefore, improve the performance of subordinate managers. But as the on-line availability of such information reaches across management hierarchies (in some companies all the way to board chairpersons), reduced risk taking and its effects begin to take hold. Managers are reluctant to make decisions on the basis of information that their superiors receive simultaneously. As one plant manager said to his boss in division headquarters: "I'm telling you, Bob, if you're going to be hooked up to the data from the pumps, I'm not going to manage them anymore. You'll have to do it."

Birth of the information environment

Another consequence of information technology is more difficult to label, but its effects are undeniable. I call it the "information environment." It refers to a quality of organizational life that emerges when the computer mediates jobs and begins to influence both horizontal and vertical relationships. In the information environment, people generally have greater access to data and, in particular, data relevant to their own decision making. The capacity for follow-up and reorganizing increases as information retrieval and communication can occur with greater ease and convenience than ever before.

One effect of this immediate access to information is a rise in the volume of transactions or operations. This increase, in turn, compresses time and alters the rhythm of work. While people were once satisfied if a computer system responded in 24 hours, those who work with computers now are impatient if information takes more than five seconds to appear. Timely and reliable functioning of the system determines workers' output, and these effects extend up the managerial ladder. Once managers become accustomed to receiving in two hours a report that once took two weeks to compile, they will consider any delay a burden. This speed of access, retrieval, and information processing is allegedly the key to improving the productivity of the organization, but few organizations have seriously considered the appropriate definition of productivity in their own operations. In the meantime, more transactions, reports, and infor-

1 "Social Effects of Automation," International Federation of Automated Control Newsletter, No. 6, September 1978.



mation are generated in an ever-shorter amount of time.

Responses to the information environment usually are accompanied by feelings about power and orderliness. To some people, the increased access to information enhances their power over the contingencies of their work. An account officer for one bank states:

"I never had such a complete picture of a particular customer before. I can switch around the format of the base for my reporting purposes and get a full picture of where the bank is making money. This gives me a new power and effectiveness in my work."

While most people agree that the information environment makes the workplace more orderly, responses to this orderliness tend to be bipolar. Some see the order as "neat and nice," while others perceive it as increasing the regimentation of the workplace. Responses of two collections managers illustrate these differences. The first described the system this way:

"The computer simply alleviates a lot of paperwork. Everything is lined up for you instead of you having to do it yourself. If you are sloppy, the system organizes you."

Another manager in the same organization regards the collections system in a different way:

"Things were a lot more relaxed before the tubes. Before, you scheduled your day yourself; now the machine lines it up for you. This means a more rigid environment because we can track things better."

Greater regimentation can also affect the environment of the professional. A vice president in one organization where professionals have come to rely heavily on electronic mail and computer conferencing puts it this way:

"I used to make notes to myself on things I had to follow up. Now those notes go into my electronic mail system. The system automatically tracks these things and they are there in front of me on the screen if I haven't followed up yet. Nothing slips through the cracks, but certainly for the way professionals usually operate, it's more regimented."

Many of the managers and professionals I talked to are wary of systems that seem to encroach on their judgment, their freedom, or the "artistry" of their professional assessments. Instead of feeling that increased information augments their power, these people resist information systems that they see limiting their freedom or increasing the measurability of their work.

At present, most professionals and managers function in fairly ambiguous environments. Information is imperfectly exchanged (often in corridors, washrooms, or over lunch), and considerable lag time usually occurs before the quality of decisions can be assessed. A continual flow of complete information, however, reduces ambiguity. For example, in the marketing area of one bank, an information system provides complete profiles of all accounts while it assesses their profitability according to corporate criteria. Top management and systems developers believed the system could serve as a constant source of feedback to account officers and senior managers, allowing them to better manage their account activities and maximize fee-based revenues. But some bankers saw the flow of "perfect" information as not only reducing ambiguity but also limiting their opportunities for creative decisions and resisted using it.

Limited information may create uncertainty in which people make errors of judgment, but it also provides a "free space" for inspiration. This free space is fundamental to the psychology of professional work. The account officers in the bank had traditionally been motivated by the opportunity to display their artistry as bankers, but as increased information organizes the context of their work, the art in their jobs is reduced.

Employees in back-office clerical jobs also tend to perceive the increased time and volume demands and the measurability of operations as limits on their opportunities to experience a sense of mastery over the work. To overcome these effects, many of the collectors keyed fictitious data into the system of account files. Their managers were confronted with high productivity figures that did not match the size of monthly revenues.

Many managers first respond to such a situation by searching out ways to exert more control over the work process. I am convinced that the more managers attempt to control the process, the more employees will find ways to subvert that control. This response is particularly likely when outsmarting the system becomes the new ground on which to develop and test one's mastery. Managers may dismiss these subversive activities as "resistance to change," but in many cases this resistance is the only way employees can respond to the changes they face. Such resistance can also be understood as a positive phenomenon – it is evidence of an employee's identification with the job.

Listening to the resistance

Critics of technology tend to fall into one of three camps. Some bemoan new developments and see them as a particular form of human debasement and depersonalization. Others are ready to applaud any form of technology as progress toward some eventual conquest of dumb nature. Finally, others argue that technology is neutral and its meaning depends on the uses to which human beings press its application. I have found none of these views sufficient.

It is true that information technology provides a particularly flexible set of technical possibilities, and thus can powerfully embody the assumptions and goals of those whom it is designed to serve. Yet, while the value and meaning of a given application must be read, in part, from management's intentions, beliefs, and commitments, this does not imply the ultimate neutrality of the technology itself. To say that information technology is neutral is like saying an airplane is neutral because it can fly to either Washington or Moscow. We know that airplanes are not neutral because we all live in a world that has been radically altered by the facts of air travel – the globe has been shrunk, time and space have collapsed.

If one accepts that technology is *not* neutral, it follows that information technology must have attributes that are unique in the world view they impose and the experience of work to which they give shape. The flexibility, memory, and remote access capabilities of information systems create new management possibilities and, therefore, choices in the design of an application.

This argument suggests three general areas for management deliberation and action in the deployment of new information systems. The first concerns policies that shape the quality of the employment relationship. The second involves attitudes toward managerial control, and the third concerns basic beliefs about the nature of an organization and the role of management.

The quality of the employment relationship

Because the computer mediation of work can have direct consequences for virtually every area of human resource management including skills training, career paths, the social environment, peer relationships, supervision, control, decision making, authority, and organization design, managers need to think through the kind of workplace they want to foster. They need to make design choices that reflect explicit human resource management policies.

For example, consider the automated collections system I described earlier. Although the system minimizes individual decision making, most managers I interviewed in that organization believe that collector skill and judgment are critical variables in the organization's ability to generate payments and have compelling financial data to support that view.

A management policy commitment to maintaining skill levels, providing challenging jobs, and promoting collector loyalty and motivation could have resulted in an information system that preserves the entrepreneurial aspects of the collector's job while rationalizing its administration with on-line record-keeping. But to assess the likely consequences of an approach to automation that strictly rationalizes procedures, managers need to understand the human logic of a job. In many cases, this human logic holds the clue to the motivational aspects of the job that should be preserved in the conversion to new technology.

What do managers do when faced with some of the more intrinsic features of information technology? First, they need to understand the kinds of skill demands that the computer mediation of work generates, and to construct educational programs that allow employees to develop the competencies that are most relevant to the new environment.

If a more theoretical comprehension of the task is required for effective utilization of the information system, then employees should be given the opportunity to develop this conceptual understanding. If an information system is likely to reduce the sense (if not the fact) of individual control over a task, is it possible to redesign the job to reinvest it with a greater self-managing capacity? As elements of supervision and coordination are loaded into jobs that have been partially drained of challenge, new learning and career development opportunities can open up. The astonishing quantity of information that is available can be used to increase employees' feedback, learning, and self-management rather than to deskill and routinize their jobs or remotely supervise them.

New systems are often presented with the intention of providing "information resources" for more creative problem solving. Unless employees are actually given the knowledge and authority to utilize such resources in the service of more complex tasks, these systems will be undermined, either through poor utilization or more direct forms of resistance.

The focus of managerial control

Because of the many self-management opportunities the information resource makes possible, managers may have to rethink some classic notions of managerial control. When industrial work exerted stringent demands on the placement and timing of physical activity, managers focused on controlling bodies and stipulating the precise ways in which they should perform.

With the burgeoning of office work, physical discipline was less important than reading or writing and, above all, interpersonal behavior. Because

people needed to learn how to behave with superiors, subordinates, and the public, managers began to control less what people did with their bodies and more what they did with one another – their communication, teamwork, meeting behavior, and so forth.

With computer-mediated work, neither physical activity nor interpersonal behavior appear to be the most appropriate targets of managerial control. Instead, patterns of attention, learning, and mental engagement become the keys to effectiveness and high-quality performance. Obviously, people have always had to "pay attention" to their work in order to accomplish it properly. But the quality of attention computer-mediated work requires is essentially different.

For instance, in almost all accounts of routine work, researchers report that employees are daydreaming and bantering with one another while they accomplish their tasks. Of course, they must pay attention with their eyes, but not so much with their brains. In contrast, people concentrating on a visual display unit must pay a very different sort of attention. If employees are to understand and properly respond to information, they must be mentally involved.

Managers can experiment to find how to make the most of people's attending and learning qualities as well as their overall engagement in the information environment. One observation that emerges from my current field research is that imposing traditional supervisory approaches on the computer-mediated environment can create considerable dysfunction. Supervisors and managers who concentrate on the physical and interpersonal behavior of employees working with information systems simply exacerbate tensions instead of creating an environment that nurtures the kind of learning and attention computer-mediated work makes necessary and compensating for some of its less obvious but potentially negative attributes.

The nature of organization & management

With information technology, managers will do a variety of tasks that others once did for them. Because of this, we are likely to see a gradual shift in the overall shape of the organization from a pyramid to something closer to a diamond shape – with a diminishing clerical support staff, swelling numbers of professionals and middle managers, and a continually more remote, elite, policy-making group of senior managers.

While these considerations should be of central importance to management policy in the coming years, as a society we are sure to see a continuing challenge to the salience of work and the workplace ir our daily lives. The traditional importance of occupational distinctiveness may be further eroded as what it means to "accomplish a task" undergoes a fundamental change. When a person's primary work consists of monitoring or interacting with a video screen, it may become more difficult to answer the questions, "Who am I?" and "What do I do?" Identification with an occu pational role may diminish, while the transferability o on-the-job skills increases. Will this have implications for individual commitment to an organization and for the relative importance of work and nonwork activities?

Information technology is also likely to introduce new forms of collective behavior. When the means of production becomes dependent on electronic technology and information flows, it is no longer inevitable that, as in the case of the weavers, work be either collective or synchronous. As long as a terminal and communications links are available, people will be able to perform work in neighborhood centers, at home, or on the road. At the same time, electronic technology is altering the traditional structure and function of communication within the organization. Who interacts with whom in the organization? Can the neat chain of command hierarchy be maintained? Should it be? What does it take to lead or influence others when communication itself becomes computer mediated? Finally, who is likely to gain or lose as we make the transition to this environment?

These developments make it necessary to rethink basic conceptions of the nature of organization and management. What is an organization if people do not have to come face to face in order to accomplish their work? Does the organization itself become an abstraction? What happens to the shared purpose and commitment of members if their face-to-face interaction is reduced? Similarly, how should an "abstract" organization be managed?

If information technology is to live up to its promise for greater productivity, managers need to consider its consequences for human beings and the qualities of their work environments. The demands for a thoughtful and energetic management response go deeper than the need for a "friendly interface" or "user involvement." The underlying nature of this technology requires understanding; the habitual assumptions used in its design must surface. Managers' ability to meet these demands will be an important determinant of the quality of work in future organizations. ∇

Managerial/ Professional Productivity

Harvey L. Poppel

Offices are the nerve centers of both the private and public sectors. And the productivity of both sectors hinges on the productivity of "knowledge workers"—the millions of managers and professionals who populate our offices.

One of the prime reasons for the poor overall productivity record of business has been its inability to raise knowledge-worker productivity. Office productivity improvement efforts to date have been focused almost exclusively on increasing the output of clerical and support staff. Yet, in the United States alone, the employment cost for managers and professionals amounts to some $500 billion annually (Figure 1)—more than double the cost of all other office costs together, including support staff, clerks, secretaries and office space. Mounting demands on managers and professionals, coupled with the impact of inflation, could easily boost knowledge worker compensation costs to $1.35 trillion by 1990. Moreover, business has been willing to tolerate a productivity leakage of hundreds of billions of dollars and still come up short in meeting the information needs of its knowledge workers.

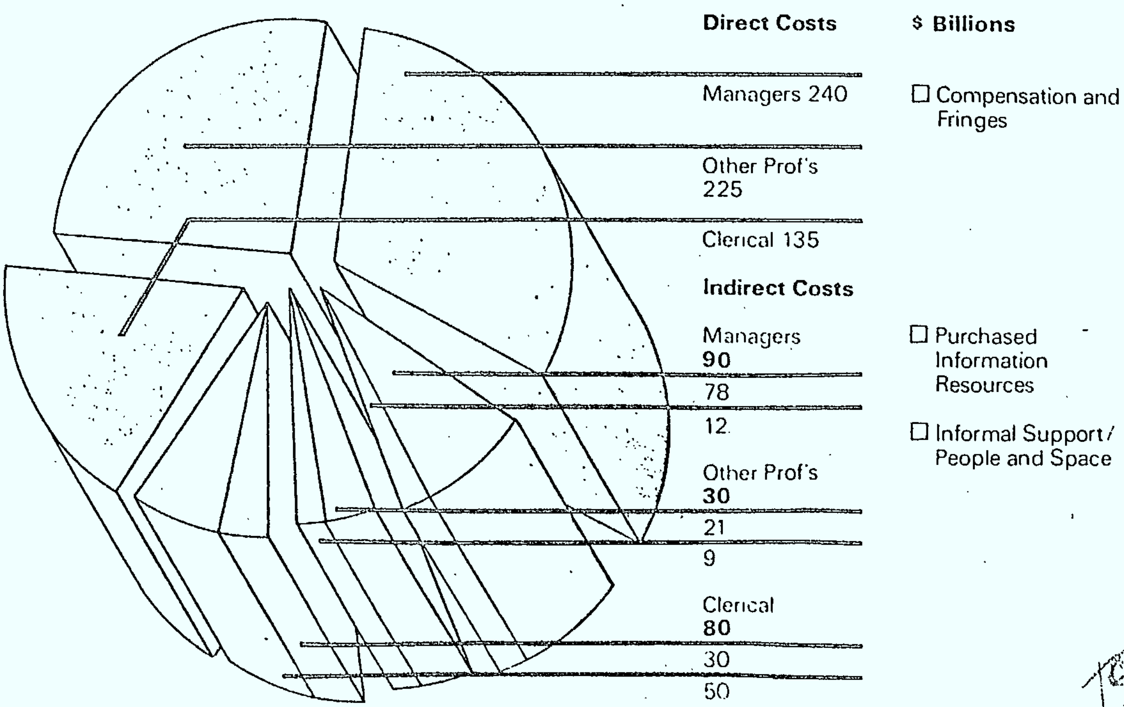
Therefore, knowledge work is one of the most significant targets of attack in the battle for increased productivity, and information processes and resources are the weapons. Information is perhaps the most vital organizational energizing force, especially among decision makers, thought leaders and other professionals. In business, as elsewhere, the "right" information is power.

Until very recently, managers and other professionals, despite their mounting information needs, have had to rely on the same information resources—pen, paper, typewriter, telephone, mail—as those of previous generations. Now a new generation of information tools promises "relief."

Increasing Managerial Productivity: The Payoff

In a recent Booz·Allen study we found that extraordinary gains in managerial and professional productivity are possible through the use of automated office tools. The purpose of the study was to determine how well-justified automated office systems can be in terms of boosting the performance

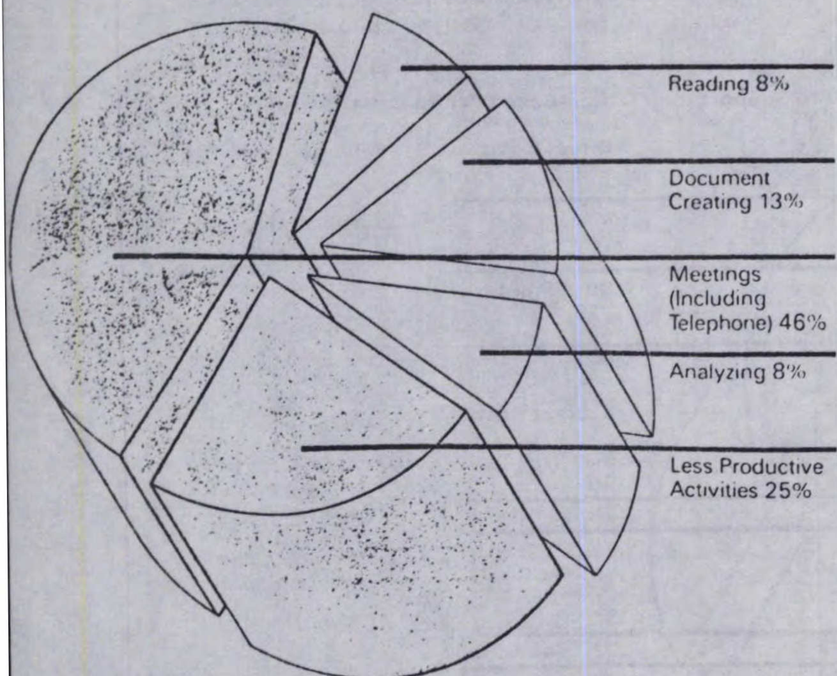
Figure 1
U.S. Businesses Spent $800 Billion in 1979 to Support their Office-Based White Collar Workers



of knowledge workers in business and government. Our finding: sound cost-benefits justification can readily be made for saving approximately 15 percent of a typical knowledge worker's time by 1985. In monetary terms, the U.S. value of this time saving alone is equivalent to more than $100 billion. To a typical business this is equal to as much as 15 percent of pretax operating income.

By 1990, time savings with an "opportunity value" of close to $300 billion could be realized annually. We use the term "opportunity value" to emphasize the fact that instead of simply reducing staff, smart executives will be driven by their business strategy to reinvest the value of their time savings into expanding and raising the quantity and quality of knowledge-worker outputs, avoiding future white collar cost spirals and motivating white collar workers at all levels by enhancing the quality of worklife. The result: a strong favorable impact on the effectiveness of executives, whose work consists largely of gathering, analyzing or transferring knowledge.

Figure 2
How Knowledge Workers Spend their Time by Activity*



*Based on Booz·Allen Multi-Client average of all time samples, not including personal time

Our recent discussions with leading-edge businesses in both the United States and Europe revealed that several have already launched major office productivity programs, and office automation will move sharply up the scale of management issues during the next two to three years.

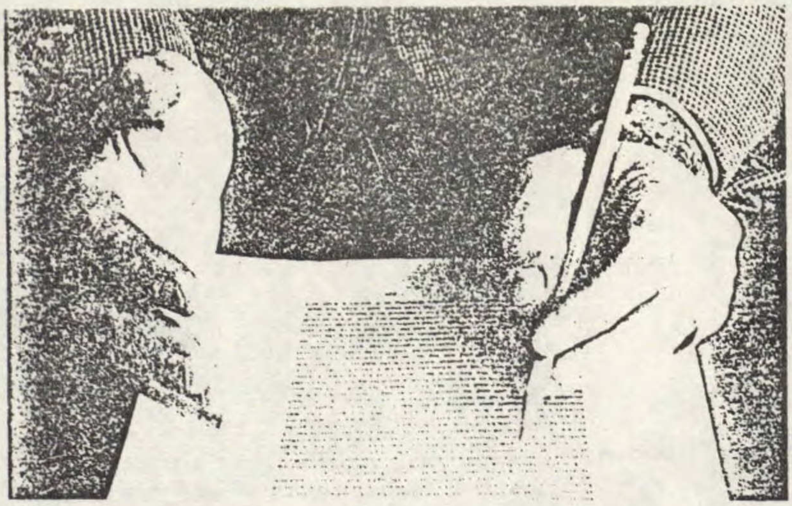
Quantifying Productivity Benefits

In the course of its year-long study, Booz·Allen had 300 typical managers and professionals self-record their day-to-day activities. In all, 90,000 time samples were gathered. The Booz·Allen study team spent more than 100 man-months interviewing, observing and evaluating the work patterns, behavior, attitudes and needs of these knowledge workers. The study was conducted at 15 major manufacturing, banking, insurance and government organizations. Nearly a million data elements describing the participants were collected and analyzed.

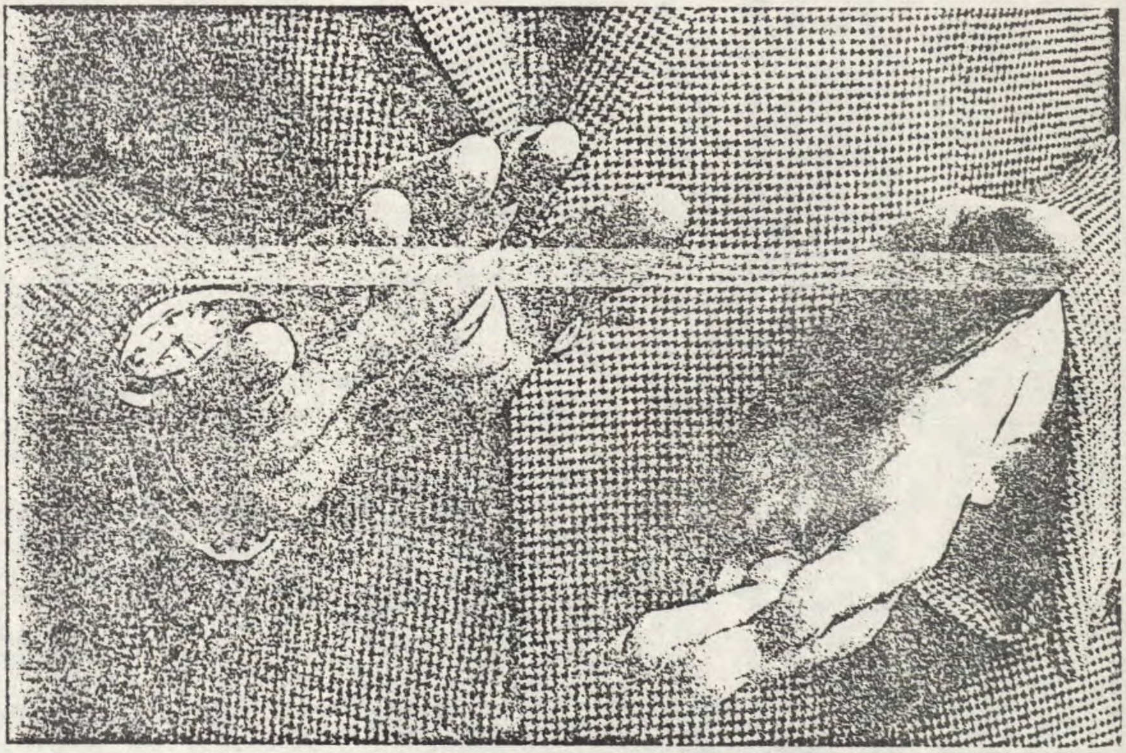
The probe enabled us, for the first time, to isolate and quantify productivity benefits and identify quality of work enhancements that could accrue through office automation and other related improvements. Analysis of the samples shows that 15 to 40 percent of knowledge workers' time is spent on activities that they themselves usually recognize as being innately less than fully productive.

Searching for information or people, copying, scheduling, and traveling to meetings are just some of the less productive ways in which managers and professionals spend at least a portion of each day. Such "time wasters" are among the most vulnerable professional activities that can be attacked through the introduction of advanced technology into the workplace. Additionally, we found that after subtracting personal time and time spent on administrative chores, the average knowledge worker spends only 4.8 hours each working day focusing on primary tasks (Figure 2). The 15 percent boost in overall time utilization achieved through office automation, therefore, may actually understate the potential gain in primary task areas.

Essentially, the study reveals that proper application of office technology can lead to several concurrent and mutually reinforcing benefits:



Photos, Karen Halverson



Highlights from the Booz•Allen Multi-Client Study of Managerial/Professional Productivity

During Booz•Allen's 18-month study, the firm gathered nearly 90,000 time samples from some 300 professionals and managers in each of 15 representative business organizations. The specific departments analyzed included finance, personnel, information systems, operations management, and research and development—all departments generic to businesses in virtually every industry. To date, the study is the most extensive survey ever undertaken of the output, working habits and attitudes of office-based managers and professionals. Among its key findings:

Managers and other professionals spend an average of 25 percent of their time in "less productive" activities—those which do not make full use of their professional skills. In addition, they spend 46 percent of their time in meetings (including telephone); 13 percent in creating documents, 8 percent in analyzing information, and 8 percent in reading. In many cases, not all of these activities are fully productive either, although they do require professional skills.

The application of automated office support tools can save an average of 15 percent of knowledge-worker* time by 1985, although the savings in the 15 individual work groups studied varied from 10 percent to more than 30 percent. The opportunity value** of this time savings is equivalent to 15 percent or more of operating income before taxes for the types of private sector business organizations studied.

Newer automated support tools can significantly enhance the *quality* of work—as well as increase total output—when incorporated into an overall program of upgrading existing office support resources and improving certain professional practices.

Certain office automation tools will contribute far more significantly to savings than others.

Business strategy will dictate the form in which benefits are realized. Full realization will require thorough top-down planning for the benefits sought and a thoughtful program to measure gains.

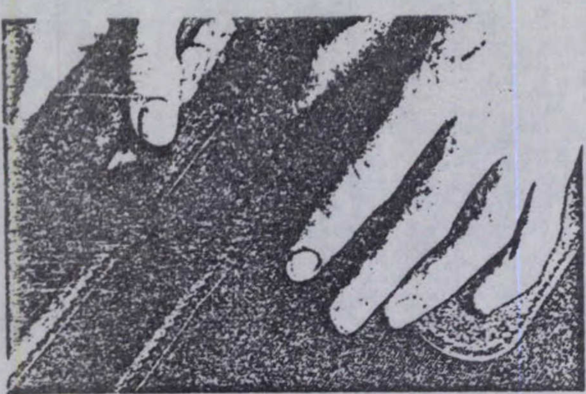
The general receptivity to an office productivity automation program should be high, since the work improvement goals of both management and knowledge workers appear to be reasonably similar.

The firms that succeed in increasing managerial productivity will be those that have top management support and are prepared to commit sizable human and financial resources to gain an early benefit stream.

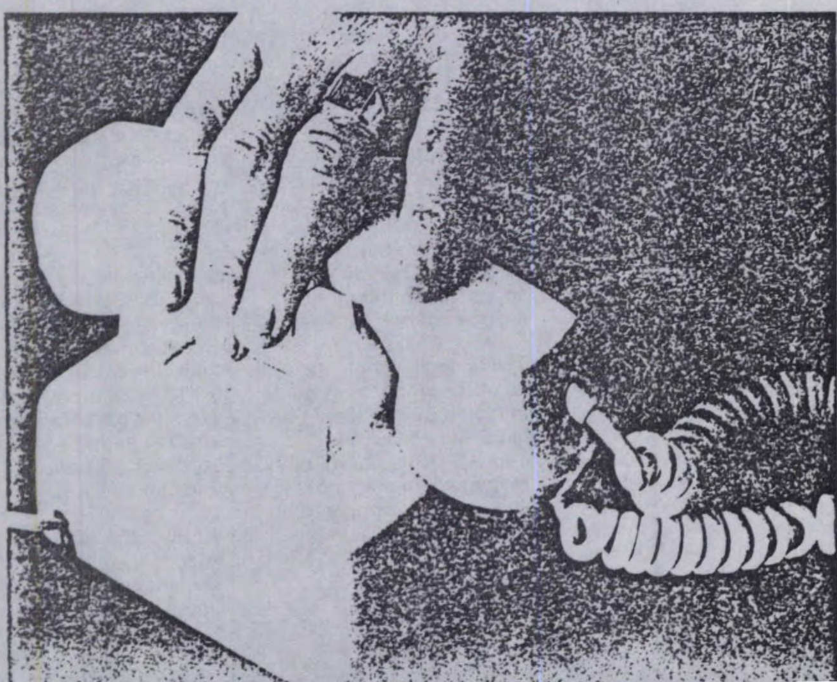
For those ready to move ahead aggressively, time-savings of more than 9 percent annually appear achievable within the next 18 to 24 months, with a potential payback within slightly more than a year, based on the opportunity value of time saved.

*Knowledge workers—managers and professionals

**Opportunity value—economic benefit of time savings



Office Automation Tools for Management	Time Wasters	Office Automation Solution
	Seeking information on sources of supply	On-line access to external supplier data bases and internal records of supplier performance
	Reaching key colleagues on the phone	An easy-to-use desk-top keyboard or speech mail system
	Traveling to periodic internal status meetings	Videoconferencing
	Excessive "what-if" number-crunching iterations	Automated decision support system
	Seeking the status of an order	Desk-top access to an information tracking system
	Extensive corrections/revisions to documented reports and correspondence	Nearby access to a powerful word and graphics composition and revision processor
	Scheduling meetings	Desk-top displays of executive calendars available to both executives and secretaries
	Generating reminders to subordinates to meet agreed-upon schedules	Tickler system that generates automated reminders



Improved *quality of work* output in terms of substance, content and thoughtfulness, timeliness and accuracy;

Expanded *quantity of work* output—broader scope and coverage, higher yield and absorption of normal growth;

Reduced (professional) input time required to produce the same outputs;

Enhancement of an individual's *quality of worklife* by allowing more opportunities to participate, less "ugly" travel and fewer interruptions (see chart at left).

How Can These Benefits Be Achieved?

In nearly every one of the 15 cases studied by Booz•Allen, systems to retrieve internally generated information accessible at the workstation level were recommended. The need to retrieve information on a timely, accurate basis with less effort appeared throughout the study to be almost universal, with better product, customer and internal performance information the most often cited needs. Also, all but one of the work groups studied could have benefited from either an initial installation or an upgrading of word processing tools. Advanced forms of word and image processing can enable knowledge workers to review and edit their work more efficiently, while producing documents with deeper reader impact. New forms of information retrieval and personal computing can dramatically speed up and improve the quality of decision making in situations where the dollars at stake dwarf the "direct cost" of the decision-making process—in fast-breaking competitive pricing situations, for example. Other forms of automation—electronic mail and a variety of activity management aids—can also boost productivity by reducing time wasted as the result of imperfect internal communication and coordination.

Other office systems were also important ingredients in the recommended mix of improvements (see chart, previous page).

Linking Productivity and Business Strategy

Business strategy should determine the form in which the benefits of office automation are reaped. Most simply, productivity improvements can be taken to the bottom line by helping to contain or reduce personnel costs. Yet we found it likely that most corporations and government agencies that invest in modernizing the white-collar environment will seek a more leveraged bottom-line gain, and often we found that more important benefits can be derived from automated office tools. Top management could choose, for example, to place more emphasis on expanding the capacity or raising the quality of work, which may have more circuitous but ultimately greater bottom-line impact.

For example: if 15 percent of the time a salesperson saved by eliminating administrative tasks or unnecessary travel were invested in greater customer coverage, it could yield revenue and profit gains many times that amount. In this example, the selection of where to focus customer coverage would be based on market strategy. If customer service is a strong strategic objective, then professional time savings in the market area would be reinvested in time spent with existing customers (as opposed to seeking new customers if expanded market-share were the objective, or reducing the number of sales personnel if reducing expenses were the strategic target).

Quality of worklife is an important "side" benefit that can be achieved through sensitive application of the new automated support tools. These benefits, which relate directly to job satisfaction and employee morale, were forecast in many of the cases studied. Typically, they derive from opportunities to reduce the frustrations associated with less productive activities, especially those that are purely clerical, as well as from enabling professionals to participate more fully in decision making through improved conferencing and the use of information transfer tools. Also, professional satisfaction should improve if professionals are allowed to reapply time saved to those activities to which they feel they give too little time—especially analyzing, creating, reading and self-development.

Most senior executives interviewed by Booz·Allen in recent years have expressed a positive "gut feel" for the potential of new automated office support tools, but have been skeptical about how to translate the potential mix of benefits into a tangible return on investment. However, our study quantified an average annual return on incremental office automation investments of well over 50 percent. And many companies we know now seem ready to plan for automated support tools accessible directly to their knowledge workers.

At Aetna Life & Casualty Co., for example, expanded forms of automation for managers and professionals will start to become available this year, followed by additional enhancements in 1982 and 1983, according to Philip J. Shaughnessy, assistant vice president of administrative services.

"Management endorses the concept of using automated office equipment and it is becoming a part of Aetna's long-term planning strategy," Shaughnessy said. "In some of our planning and investing departments, for example, terminals and sophisticated graphic devices are used to help make business decisions. Additionally, a number of managers and professionals subscribe to outside data banks."

Shaughnessy expects the major gain from automation to be the ability to give "managers information faster by allowing them to dip into a mass of data and cull from that the important things they need to know. Faster access to data which is meaningful to the individual manager and professional is the key to increased productivity."

The results of our case studies point up that no cookbook exists for taking or measuring the benefits of automation. Knowledge work is eclectic, and the potential gains, while cumulatively large, will come in small pieces. If not planned and measured, they could leak away.

The planning of benefits should be keyed to business strategies, their critical success factors and the MBOs they generate. The improvement program should be viewed with the larger perspective of an overall strong top management commitment to good people, attractive rewards/incentives, and sound organization structure. The winners—those able to realize the full benefits of improved knowledge worker productivity—will be those corporations and government offices whose senior executives identify a productivity program and begin now to organize for and plan the introduction of automated office tools.

The major obstacle to success is not, as some have asserted, end-user receptivity to the technology, but rather the magnitude of financial and people resources needed to achieve widespread use. Much of that investment is in people-time to orchestrate the changes and to involve, orient and train the end-users. We have found that this type of program can be set up on a self-liquidating basis. However, even with unlimited funds, there is a shortage of qualified practitioners to implement office automation programs for professionals. This problem is magnified even further by the diversity of systems, human factors, and other skills required, as well as by the need for more businesses to designate an organizational entity to direct such an effort.

Planning a Knowledge Worker Productivity Program

Despite their promise, neither automated office tools nor office productivity management are panaceas. Public and private sector organizations that automate without adequate planning and prior small-scale testing may be saddled with expensive equipment that adds nothing to productivity or work quality. Only when properly conceived and implemented does an automation and productivity program strengthen the basic organizational fiber and structure of an institution, yielding direct and measurable gains in profitability, productivity improvement and work performed. No one approach to office automation and productivity improvement will meet the needs of every business or government agency, but successful programs will almost certainly share some common features.

A firm commitment from senior management is an essential precondition for success. Organizing a top-level steering committee is one good technique for demonstrating that support and ensuring that the benefits to be achieved are driven by the business strategy—and implemented in a top-down approach. A task force charged with the responsibility of developing the program could then be established one level below the steering committee. Membership in the task force should reflect the fact that any communications-oriented automation/productivity program must inescapably cut across organizational lines and require interdisciplinary expertise. Thus, in addition to general managers thoroughly familiar with business operations, human resources specialists, office facilities experts and information systems analysts should all have a role in developing and executing the program.

As a first step, time and behavior studies of the sort developed by Booz•Allen could be conducted to assess the amount of time to be saved and how it could best be reinvested. Based on these findings, initial introductions of "off-the-shelf" office technologies can contribute to early gains in knowledge worker performance. Employed in tandem, the process of studying time and automation tools provide the new vehicles to manage office productivity. Through the process of office productivity management, it is then possible to link strategic management objectives and managerial performance.

Such office productivity—through automation programs—must rightfully be seen as an important element of the corporation's overall business strategy. The companies to benefit most will be those whose programs are supported by top management and supplied with adequate financial and human resources. Most successful of all will be firms whose senior managements possess the foresight necessary to capitalize on the competitive edge afforded by the emerging technology of the automated office.

BUSINESS BRIEF

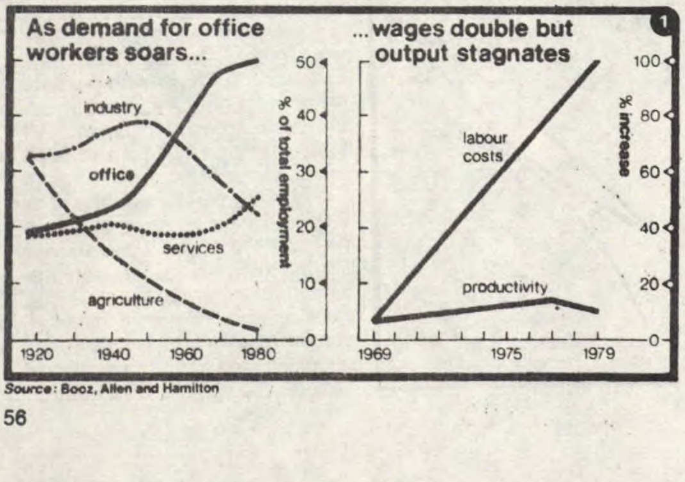
Death sentence for paper shufflers

David Gordon arrives at his London office, speaks into the voice recognition security device to unlock his door. As he enters, the lights and air-conditioning go on automatically. Sitting down, he switches on his small desk-top terminal. On its display screen the following words appear: "Good morning, after you left at 6.35pm, the following happened. . . ." He switches to the large flat wall screen, which lists a rescheduled meeting with Bill Kelly at head office, then draws a bar chart of the day's expected sales. He checks his mail by displaying it on the screen—President Clive Greaves in the New York office regrets he will not be able to attend the video teleconferencing session at 2pm (GMT) but will fax his revised forecasts over beforehand.

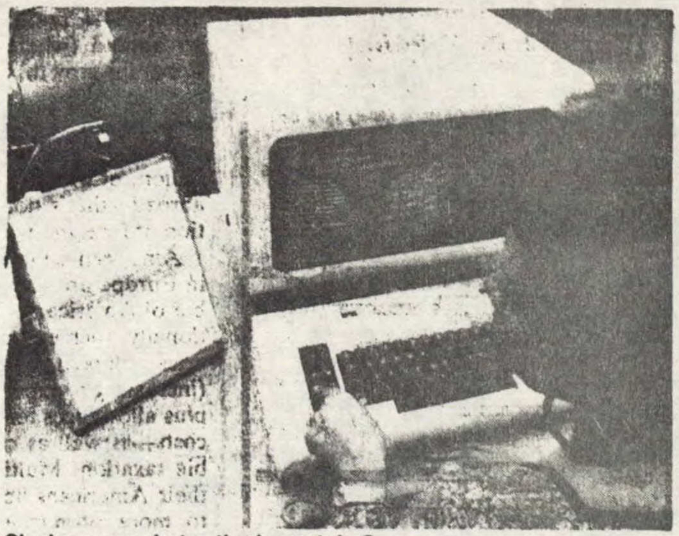
Science fiction? Not at all. Most of the technological ingredients of the ballyhooed "office of the future" already exist. But few companies have tried to fit all the electronic pieces together and pioneer paperless offices. For good reason; none of the electronic office equipment manufacturers—not even IBM or Xerox—has yet succeeded in making the devices sufficiently "friendly" so that typical office workers (rather than computer people) can use them easily and well. The office of the future will not be the computer room. Secretaries and executives are not (nor do they want to be) programmers and systems analysts. Equipment manufacturers have not yet got the message. Much of the electronic office machinery coming on the market requires users to be familiar with special codes and certain computer techniques. Not until all the clever new products are as simple to use as, say, the telephone will the "office of the future" truly arrive.

Nor, yet, can all the individual pieces of the future all-electronic office—be they word-processors, intelligent copiers, facsimile transmitters, teleprinters, electronic mail machines, video conferencing equipment and computerised libraries and data bases—communicate fluently with one another. The problems of standardising the digital language, the bandwidth of the communications channel and the so-called protocols involved (so equipment from rival manufacturers can talk to each other) have yet to be solved. But solved they will be—probably within the next two to three years. The paper explosion cannot continue. Consider the problem in America (to which all the charts refer).

American firms last year spent (by management consultants Booz Allen's broad definition) $800 billion running their offices. Some $600 billion (75%) went on wages and benefits for white collar workers; the remainder covered equipment, rent, heat, light and other indirect costs. Office salaries and benefits are rising at a rate of 10-15% per year. Meanwhile, the ranks of the white-collar brigade are continuing to swell rapidly as America evolves further away from being an industrial society into a mainly service-based economy (chart 1). The department of labor in Washington predicts that half of America's 104.3m civilian workers will be employed in offices by 1985. If such trends continue unabated, say market researchers at



Source: Booz, Allen and Hamilton



Slaving over a hot cathode ray tube?

the Yankee Group in Cambridge, Massachusetts, direct office costs in America could reach $1.6 trillion by 1990.

Great paper chase

Meanwhile, inflation is confounding attempts by office managers to contain costs. The price of the office's raw material—paper—rose 87% between 1973 and 1979. It has risen by a further 26% since. The cost of producing a business letter is now reckoned to be somewhere between $5 and $8. The Yankee Group estimates there are on average about eight file drawers of information containing some 18,000 documents for every white-collar worker in America. Between them, the country's white-collar workers produce 72 billion documents annually and maintain and file another 300 billion or so. The information explosion, it seems, is proceeding at a rate of about two file drawers per office worker each year.

Nor have communication costs escaped inflation. Even efficient (by world standards) Ma Bell has been forced to raise telephone rates—by 160% between 1970 and 1977. By 1982, they will probably have risen a further 100%. Office workers in the United States currently make around 100 billion telephone calls a year, at an average cost of 15 cents per call. That adds up to $15 billion a year. The average manager spends 80% of his or her time just in communication—transmitting or receiving information (not, of course, all by telephone). Another survey found that the average office professional (ie, marketing man, accountant, statistician, lawyer, etc) wasted 20-30% of his or her time just looking for information. The cost of a misfiled document is believed to amount to more than $60. Firms generally misfile between 1% and 5% of their records. They lose permanently half those misfiled.

Office productivity may now be declining. Booz Allen believes office productivity in America probably reached its peak in 1978 and has been falling since. Meanwhile, office labour costs have doubled (chart 1). Some studies indicate that clerical and secretarial workers are no more than 40-60% as productive as they could be. Executive productivity is thought to be only 60-75% of what it might be.

Might be what? Assessing office productivity—and choosing means to improve it—is notoriously difficult. How, for instance, do you measure the productivity of a secretary or administrative assistant? By the number of words typed or telephone calls made? Hardly. How, even, do you assess the value of employee morale to a business? Or the esprit de corps a new manager may bring to a department? The only answer: subjectively and with difficulty. Perhaps the best that can be done is to measure company profitability over several years. That, at least, ought to reflect the total productivity of the organisation—plus, of course, the effectiveness of the management.

Slow-fix solutions

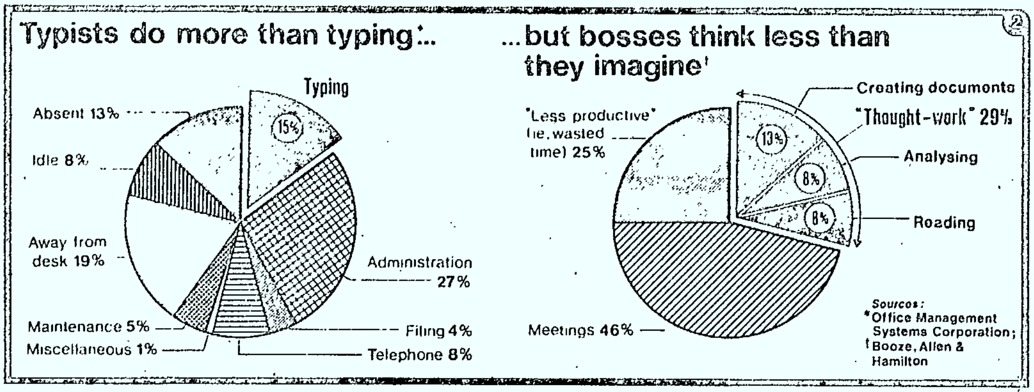
It follows, then, that there are no "quick fix" solutions to the office productivity problem. Buying an expensive piece of office automation (like a word-processor), firing several secretaries and demanding more from the rest is about the surest way to make matters worse. In fact, concentrating on clerical workers, and particularly secretaries, misses the point altogether.

The mistake has been to treat the office as if it were a factory, where centralisation and assembly-line procedures can be applied to boost productivity. In consequence, the main goal of office automation so far has been to turn out more paper faster. Electric typewriters replaced manual ones. Then came automatic correcting versions, electronic memory models and now word-processors. But typing is only a small part (about 15%) of a secretary's job; far more important is the general administration (around 27%) she performs (chart 2). Though great strides have indeed been made to churn out more paper, few equipment suppliers have begun to think about trying to improve the quality of the information printed on it. Practically nobody has attempted to develop means to make sure that others actually bother to read it. The four rules of improving office productivity ought to be:

○ Reduce the flow of paper, aiming ultimately to abolish it.

○ Ensure that information has to be "captured" (ie, keyed into a piece of equipment) only once. Then, once stored, make as frequent use of it as possible. The costly part is creating and capturing data in the first place; storing and retrieving it is cheap.

○ Focus more attention on the executive suite, less on the secretary's desk. Study how managers and other professionals use (waste?) their time in the office. IBM estimates that there are nine "principals" (ie, office employees who can delegate work) for every secretary. When salaries (and perks) are taken into account, the ratio of their respective costs is closer to 30 to one. Executives and other white-collar professionals account for 73% of total office costs. And, in terms of what they are actually hired to do, bosses are far less productive than most of them assume. A $1.5m study recently completed by Booz Allen suggests that so-called "knowledge" workers (ie, professionals and managers) spend remarkably little time (29% of their week) performing actual "thought" work and a disproportionate amount (46%) in meetings (chart 2). Better organisation—including prepared agenda, agreed discipline, restricted numbers, etc—can halve such time-consuming tasks.



○ Finally, start now to prepare for the day when the integrated electronic office will be practical—and justifiable.

Toe in the water

Getting office automation through the executive's door is going to need persuasion, patience and tact. Basically, it means getting pencils, paper and pocket calculator swapped for some form of computer terminal (called in the trade a **multifunction workstation**). One large American oil company introduced workstations in a big way after looking at how 66 managers and professionals in its personnel department were wasting their time. Each spent an average of 1.2 hours a week using a copying machine, 1.6 hours failing to reach someone by telephone (even though the American telephone system is efficient), 2.5 hours writing long-hand messages in the office (plus 7.6 hours writing reports at home) and three hours on jobs he ought to have delegated. The department's wastage was costing over $1.5m a year—or $23,000 for each person in it.

Some of the easiest—and cheapest—improvements to office efficiency come from giving people simple **word-processors**. These are essentially a typewriter keyboard linked to a small computer, a television-like display, a "floppy-disc" memory unit and a cheap little printer. The latest generation of baby word-processors (like IBM's Displaywriter and the Wangwriter from Wang Laboratories) are among the most "friendly" terminals produced to date. They show what can be done for around $7,000-8,000.

Most companies experimenting with office automation let their people play with a word-processor or even a proper workstation for several months before having to use it seriously. Workstations tend to sell themselves once the user begins to experience what they can do. Like:

○ Provide easy access to extensive data bases of information, inside and outside the company.

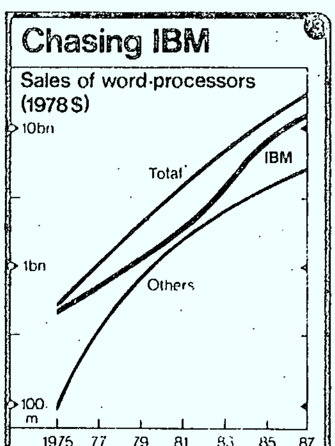
○ Store and retrieve vast quantities of information at the press of a button.

○ Prepare draft reports, edit them and produce instant clean copies automatically.

○ Perform clever analytical tricks that allow information to be turned quickly into graphs, charts or diagrams, often triggering in the process novel insights that might otherwise be missed. An executive examining financial statements, for instance, might decide to plot profits versus revenues, then profits against operational costs, then a comparison. While a task like that could take hours or even days to carry out manually, it takes minutes at a workstation.

The firm planning to automate its offices really seriously should aim at providing one workstation eventually for every two or three employees. That is what IBM is quietly working towards inside its own offices. Most firms are nowhere near that. In American business there are currently 48 employees for every computer terminal; in Europe over 100.

The next important piece of office automation firms need to consider is **electronic messaging**. The Yankee Group reckons this could save two hours a day for every non-clerical worker in an office. Using it, a message can be sent to an individual in seconds. But, unlike the telephone, if the party is not there the message automatically gets stored until the individual checks the electronic "message board".

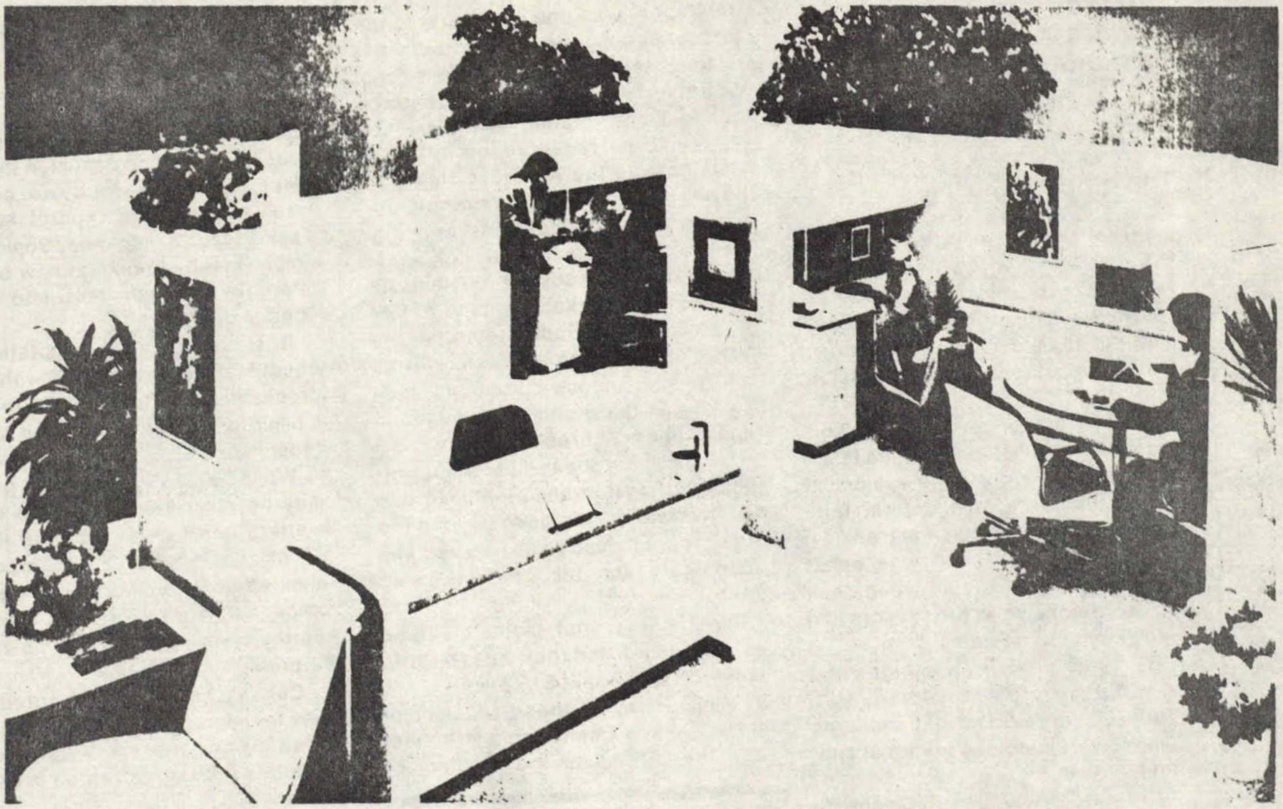


With **electronic mail**, text can either be distributed direct to workstations by facsimile transmitters, or letters opened in a central mail room can be scanned by an optical character recognition device and then distributed by cable to the appropriate workstation. Already gossip, as well as graffiti and even pornography, is finding its way into electronic mail systems.

Teleconferencing is also expected to bring significant improvements to office productivity. Studies suggest that up to 35-40% of business travel could be replaced by "narrow band" telecommunications—ie, just a loudspeaker telephone plus a facsimile link to display simple graphics. An additional 10% could be replaced by full video teleconferencing. But, despite the optimism, it is hard to put a value on personal contact.

And who is going to supply all this wonderful new technology? At the last count (in 1979) there were 106 suppliers of office automation products in the United States alone. The market is, potentially, vast: upwards of 30m workstations in America, says Frost and Sullivan, with possibly the same number again split between Europe and Japan. All told, that could add up to $300 billion worth of business.

Nobody really doubts that IBM will leave the competition in the dust (chart 3). It has started to lay plans to use its satellite communications links to bring the immense power of its huge computer network directly to individual workstations in offices, factories, shops and even homes.



THE OFFICE OF TOMORROW

Is there a future in your office?

Electronic office automation holds promise for boosting productivity. And Canada's 'hi-tech' companies are ready to respond to new needs.

By John Leng

Electronic office automation has the potential for making significant improvements in both the productivity and effectiveness of organizations. Fortunately, it is becoming available at a time when it is increasingly needed as evidenced by mounting government deficits and declining profitability of industry and commerce.

Looking at the driving forces in this industry—U.S.A. and Canada—I believe that many of the trends in this industry south of the border are also applicable in Canada.

The U.S. Department of Labour states that from 1952 to 1977, manufacturing industries in the United States only grew in their production work force by 5 per cent yet in the same period their non-production (white-collar) work force nearly doubled.

Furthermore, the non-production worker's average weekly salary grew 50 per cent over that of the production workers and today they number nearly 52 million (over 50 per cent of total employment) and represent about $1,000 billion in direct costs.

International Data Corp., a U.S. computing and office information consulting company, reports that this work force is expected to reach a total of 61 million people by 1990.

In Canada the problem of office productivity is due to the fact that while our industrial productivity has almost doubled in the last decade, our office worker productivity has grown only a few percentage points or is essentially flat in comparison.

Looking at what has happened in agriculture and manufacturing as a comparison it would seem that the office segment has a long way to go to catch up.

North America's agriculture has seen dramatic productivity improvements in the last 50 years and it is now one of the highest capitalized industries per worker and the most competitive in the world. It is not uncommon to have a small family farm with two or three people in the capitalization of a few hundred thousand dollars of equipment.

Manufacturing has undergone similar changes but to a much lesser extent with equipment capitalization per worker averaging around $30,000 and still growing. In contrast, the investment in each office worker is less than 20 per cent of that for a manufacturing worker.

To achieve significant productivity improvements in this segment, a

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John Leng is president, AES Data Ltd. This report is from a recent speech to the Canadian Club of Montreal.

Is there a future in your office?

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modest investment of $10,000 per U.S. white-collar worker over the next 10 years resulting in $500 billion in equipment sales would still only put their employee investment at half that of today's manufacturing worker.

In 1981, 60 per cent of the $13 billion spent on office automation in the U.S. went to support-type equipment such as copiers, duplicators, telephone exchange equipment and so on while the remainder was spent approximately evenly between desk top computers, word processors and video key entry stations.

By 1986 these percentages will be approximately reversed with nearly 60 per cent of expenditures going towards various personal support systems.

The word processing segment, an area where significant productivity improvements are demonstrable, has been a key area of focus accounting for over 13 per cent of all the U.S. expenditures on office equipment.

This segment is expected to grow faster than average, accounting in 1986 for $4.6 billion in sales.

Today AES Data Ltd., IBM and Wang, the top three word processing companies in the world, jointly supply over 50 per cent of the market volume.

However, future emphasis will be on managers, administrators, and professional and technical workers. This group, accounting for 50 per cent of the white-collar work force, have received the greatest average salary growth over the last 10 years and they will become the users of work stations, personal desk top computers and supporting communications systems.

By 1986, 20 million workers (⅓ the white-collar work force) in the U.S. are expected to be using an electronic support device of one kind or another and total sales in that year are expected to reach $33 billion.

All of this dramatic growth of equipment will not come without significant changes in the office.

Most electronic work stations involve a video display terminal (VDT) which has become of great interest among newspaper reporters, an industry that was one of the first to go through rapid change over to VDTs.

Newspaper unions took a strong position to obtain many contract concessions relating to the use of VDTs and in a recent report by Clatin Hendricks to the American Newspapers Publishers Association he states these concessions primarily relate to environmental concerns. These concerns cover such items as employee eye examinations, safety committees, periodic tests in the VDTs for radiation in mission levels and miscellaneous conditions such as screen glare shields, adjustable chairs and rest breaks.

In some European countries, particularly Sweden and Germany, this union influence has gone beyond the newspaper industry and has become mandatory for all products sold there.

We believe that many of these standards will find their way to North America in the next 5 years.

While many of these recommendations have been mutually beneficial there remains the problem of sorting opinions and facts and intelligently handling the emotional concerns.

> ***With 46 per cent of the work force expected to be using VDTs by the year 2000, we can not brush off environmental concerns.***

Recently the Public Service Alliance of Canada requested temporary work transfer for expectant mothers on the belief that no medical doctor or scientist will guarantee no harm will come to their unborn child.

The article concluded, as if to give authenticity to the claims, that two women using VDTs in a Toronto newspaper gave birth to babies with birth defects—a claim not based on scientific analysis but on circumstantial evidence as is the case in most of these claims.

However, with 46 per cent of the work force expected to be using VDTs by the year 2000, not to mention all of our televisions (which emit higher levels of radiation) and the increasing use of personal computers and video games, we cannot brush off these concerns.

In order to ensure both the physical and mental health of our populace and still take advantage of the economic benefits of this new technology, we believe industry, unions and governments should jointly fund thorough and precise research into all areas of concern.

AES has taken the first steps to make ergonomics (environmental issues) a major component in their engineering effort and they are actively involved with the Federal Ministry Task Force on microelectronics and employment working on how best to integrate new technology into the offices of the future.

It is a common temptation to equate office automation with data processing and to delegate responsibility for its implementation to that group.

While data processing groups may be competent to handle these matters, the key point is that this is an office productivity and management effectiveness problem—not an office automation problem—and is worthy of its own focus within an enterprise.

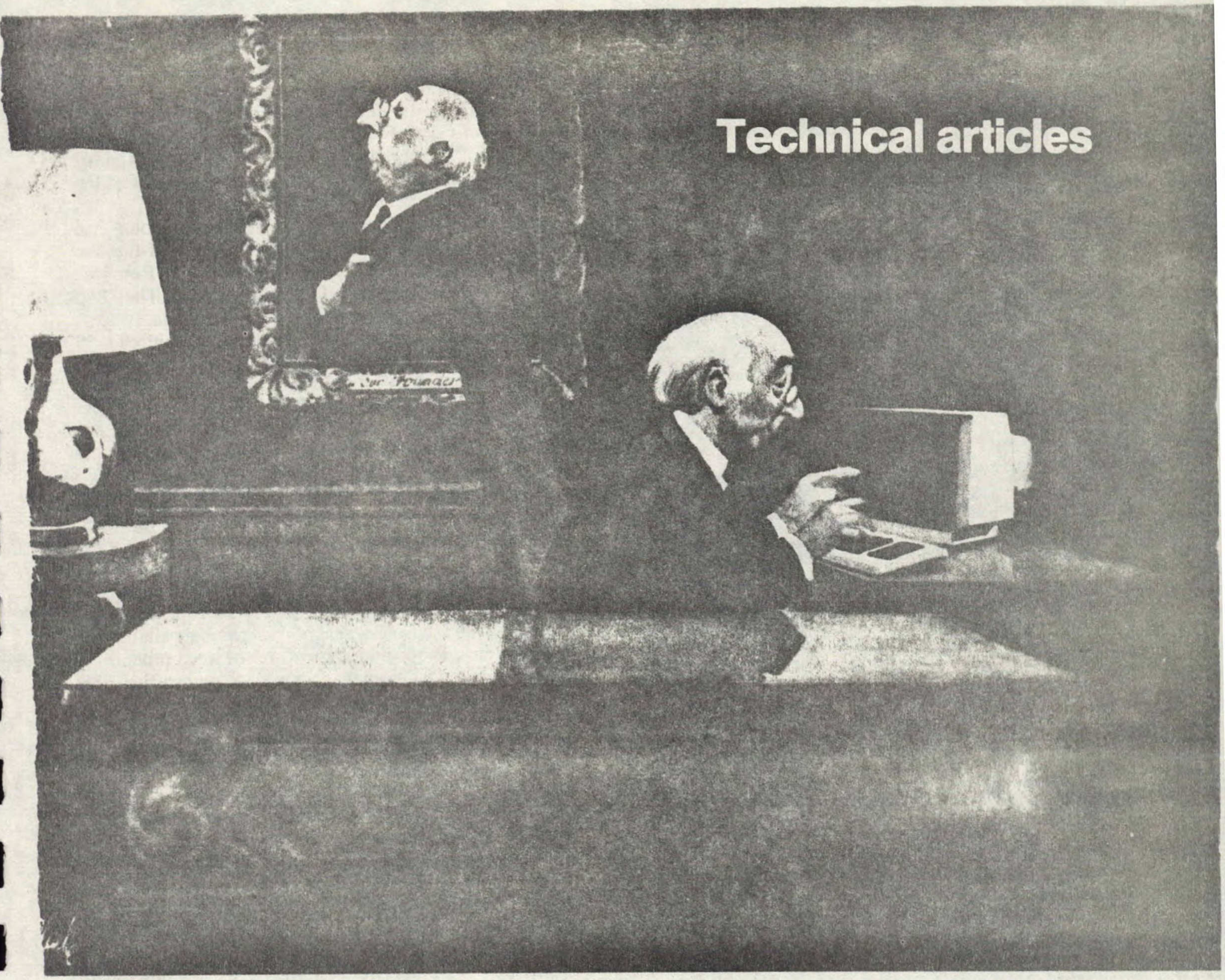
Canada has readily adapted this new technology and in the word processing sector, in particular, matches the United States in its application.

Among the many pioneering Canadian companies and organizations applying this technology are the major transportation companies; communication companies; most major banks; the legal and engineering professions; most federal government departments; and increasingly departments and agencies of provincial governments.

The Canadian electronics and computing industry has taken an early leadership position in major segments of the worldwide office automation market. For example, Northern Telecom and Mitel are establishing strong reputations and market share positions in communications, and similarly AES Data and Phillips-Micom are doing the same in word processing.

Other major companies such as IBM and Xerox have committed parts of their product lines in typing and copying machines to their Canadian operations and a host of Canadian electronics computing companies are also establishing important roles in numerous segments of the market.

All these Canadian-based high technology companies are now available to respond to Canadian business and government needs and with the continued responsiveness of these groups, we can benefit economically by planned technology on a large scale earlier than many other countries and insure a "Made in Canada" future in the office. □



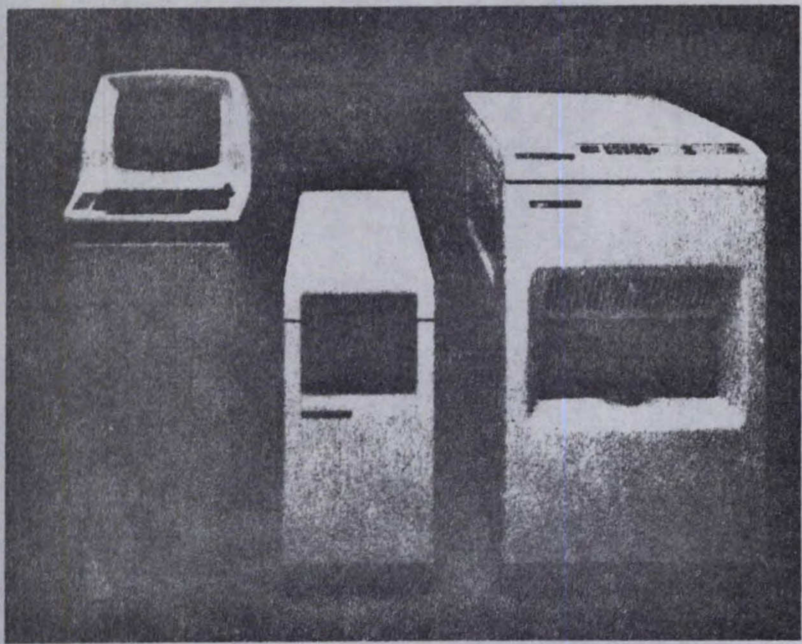
SPECIAL REPORT
Automating offices from top to bottom

Software architectures that integrate many new jobs are making computer systems at home with top management and clerical workers alike

by Tom Manuel, *Computers & Peripherals Editor*

☐ The crest of the new wave in office automation, which is reaching into areas beyond mere word processing, is seen in systems that comprise more than single stand-alone or clustered terminals. The work stations of these new systems are tied together by local networks and offer a variety of capabilities such as electronic message services, access to data bases, personal computing, and printing. Moreover, expensive hardware resources such as disk memories and laser printers may be shared by many work stations, and information may be exchanged among them.

At the forefront in bringing the computer into the office is the application of software architectures and the techniques of modern computer science. Virtual memory, large addresses, partitioning, multitasking and intertask communication protocols, bit-map displays, new data-access methods, content-addressable or associative indexing, and a productive modular programming envi-



1. Electronic printing press. The Xerox 8000 Network Systems Print Server station delivers 12 pages per minute of high-quality electronic laser printing for users of an Ethernet-based office system. The printer is shown in the box on the right.

ronment, for example, have been developed primarily at universities for large computer systems. Now these techniques have been married to the cost-effective distributed systems made possible by local networking and by the availability of low-cost, powerful microcomputers and large but affordable quantities of memory, with the result that modular and flexible office systems are beginning to appear in the marketplace. No longer is the work station geared only to the secretary or clerk. The new systems do so much that they are being perceived as a necessity by top-level managers and professionals.

Who's doing what

Some of the recent office automation product announcements have come from companies with long experience in office systems or distributed data processing, who have clear commitments to supplying systems for the integrated office systems.

Xerox Corp.'s Office Products division in Dallas late last year introduced several office automation products with functions that can be integrated into a total system through Ethernet. This is the company's well-known local network, which it continues to develop jointly with Digital Equipment Corp. in Maynard, Mass., and Intel Corp., Santa Clara, Calif., and is licensing at a very modest fee. The initial 8000 series contains a centralized, sharable file storage system called a file server, a laser printing station called a print server (Fig. 1), and communications servers. The communication servers can connect products to the net that have no built-in Ethernet interface or they can connect individual Ethernets together or to long-distance networks. Xerox's system is built upon a solid foundation of software technology that it has been quietly working on for several years.

Perhaps the leading company today in combined experience and technology in local networking, distributed data processing, and integrated electronic office systems is Datapoint Corp., San Antonio, Texas. Datapoint, over several years, has gradually assembled a state-of-the-art integrated electronic office system with local networking used by many customers.

Keeping the improvements coming, Datapoint has recently announced a new, very powerful, top-of-the-line processor, the model 8800, for the Attached Resource Computing (ARC) network (Figs. 2a and 2b). The 8800 handles 1 million instructions per second, and systems can be created using as many processors as required—50 of them, for instance, interconnected with ARC and using the company's new Resource Management System (RMS) operating system, would make a computing system able to handle 50 million instructions per second, according to Victor D. Poor, executive vice president for research and development.

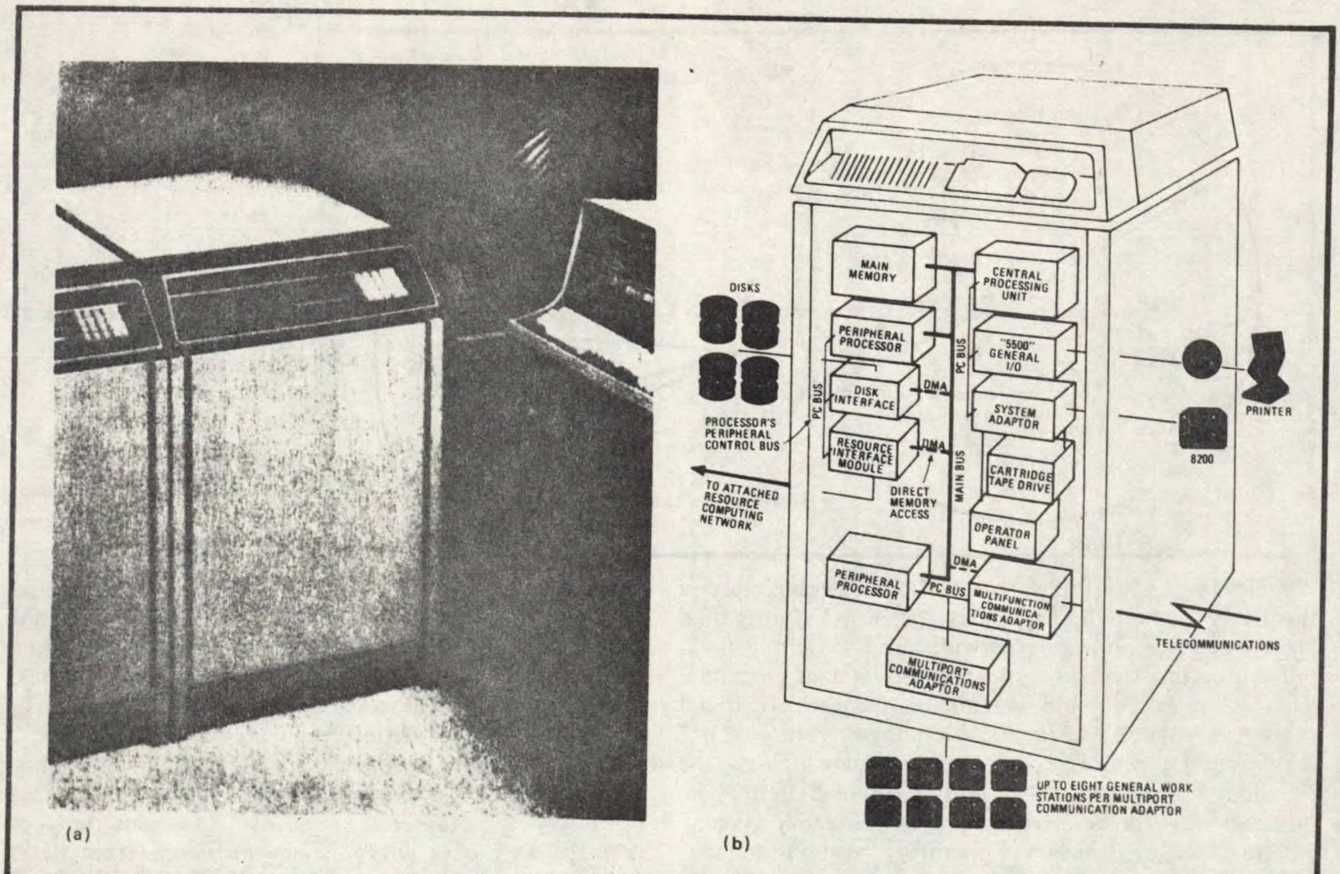
Taking a slightly different approach is Prime Computer Inc. of Natick, Mass., which added software for office automation to its large 32-bit minicomputer systems. Many terminals can be connected to these minicomputers and the minicomputers can be interconnected by the Primenet network. To the broad spectrum of data-processing and business-analysis software available on these systems, Prime added software for word processing and for what it calls management communication and support, which includes electronic mail, electronic filing, and activity management. The system, like Xerox's and Datapoint's, is based on well-developed software.

The Electronic Office Systems group of Northern Telecom Inc. (formerly Northern Telecom Systems Corp.), Minneapolis, Minn., was a pioneer with Datapoint in distributed data processing. It has introduced word-processing software (called Omniword), high-quality printers, and a powerful processor work station, the model 585. The 585 will put a new top on the line of processors that can be interconnected with the Omnilink local network.

Startup companies are also aiming at this new field. Apollo Computer Inc. in Billerica, Mass., and Convergent Technologies, Santa Clara, Calif., have developed low-cost 16- and 32-bit microcomputer systems using some of the newest hardware and software architectures. The 32-bit Apollo Domain and the 16-bit Convergent Family, like the Xerox and Datapoint systems, spring from a software-based technology and a new concept in computer architecture. The architecture is basically a network of powerful personal computer work stations with advanced software and video display techniques. Both the Apollo and Convergent systems are being marketed to original-equipment manufacturers as foundations for integrated office systems and both systems have a good software development environment.

Others get involved

Many other companies have products that automate parts of the office or single functions like stand-alone word processing. Some of the larger, more significant companies, like IBM, DEC, Exxon, Burroughs, Honeywell, Hewlett-Packard, and Wang, offer all, or most, of the pieces for totally integrated systems. The pieces can



2. Outside/inside. The powerful, 1-million-instruction-per-second Datapoint 8800 computer is shown in (a) in an office with a keyboard/display work station. The interior of the compact 8800 appears in (b). The 8800 can serve other systems in the ARC network.

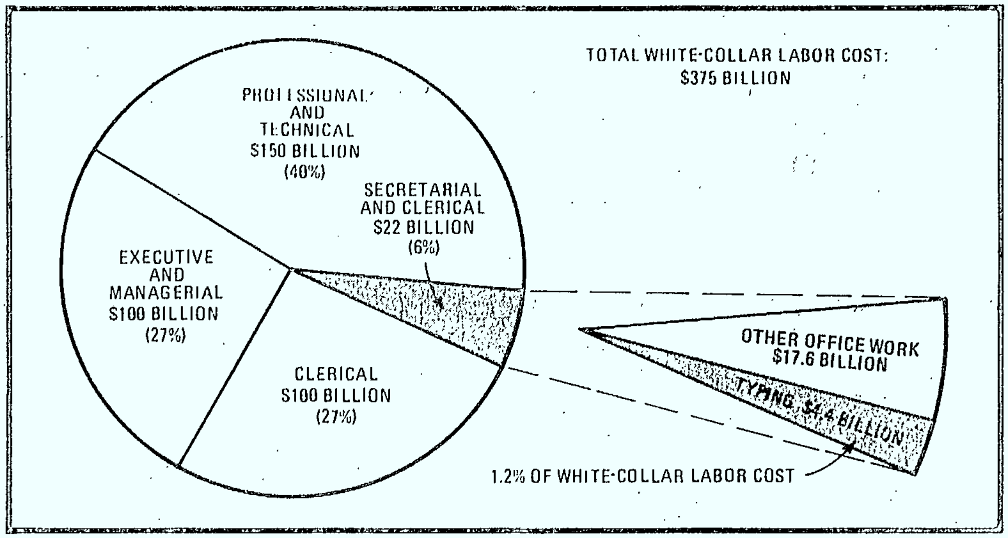
usually be interconnected, but these companies have not yet taken a total system integration approach. Undoubtedly they are working in this direction.

Wang Laboratories Inc., Lowell, Mass., long a recognized leader in clustered and stand-alone word processors as well as distributed data processing, appears to be well on the way to a fully integrated system and is working on local networking. International Business Machines Corp. has issued statements of direction indicating future moves to integrate products from its three major computer system divisions. Exxon Corp., with a $200 million collection of businesses operating in the information-processing field as Exxon Enterprises, New York, has recently consolidated three of its systems companies (Qyx electronic typewriters, Vydec word processors, and Qwip facsimile systems) into the Exxon Office Systems Co. Initially it looks like an integration of marketing, and probably purchasing. Integrated manufacturing will likely come later. There is no indication how soon Exxon will be able to start integrating the products of this new company. Exxon's Zilog Inc. in Cupertino, Calif., offers its MCZ-2 microcomputer systems, Z-Net, and software for building office systems.

DEC, the minicomputer leader, so far is only testing the waters in integrated office systems. The shared-logic, word-processing systems on the PDP-11 have access to the standard data-processing and -communications functions currently available on these systems. DEC also has its WS200 Series of clustered word-processing systems and the WS78 stand-alone word-processing system, which is price-performance-competitive with the IBM Displaywriter and the Wangwriter.

Though no company in Western Europe is yet offering a completely integrated office automation system tied together with a local network, several companies clearly have most of the pieces. West Germany's Siemens AG offers small-business computers and word-processing systems that communicate with each other. According to Ian A. Galbraith, director, Communications and Information Systems division of Mackintosh International Co., a research and consulting firm in Luton, Beds., England, and San Jose, Calif., the strategies of companies like Philips Gloeilampenfabrieken of the Netherlands, Nixdorf of West Germany, and Olivetti of Italy indicate they are likely to offer integrated systems soon. Mackintosh has recently published a report entitled "Electronic Office Equipment—European Market Trends to 1983."

Nexos Office Systems Ltd., Bristol, England, a company with word processing and facsimile systems, is working on software to provide a higher level of integration in office systems beyond text and data handling. It is writing application software—"a mountain of software," says Chris Ellis, director of strategy at Nexos—to add image and voice along with text and data to supply the next level of integrated computer-based office information systems. This software is being written for the Delta 2 computer from Delphi Communications, Los



3. Office work. Most of the workers in offices are not secretarial and typing personnel and most of the work done by the secretarial staff is not typing, which represents only 1.2% of office labor costs. New office systems must help with numerous other functions.

Angeles (an Exxon Enterprises Co.). The architecture of the Delta 2 computer combines the best features of a large computer and the bandwidth and switching flexibility of a private automatic branch exchange (PABX). The Delta, which could be called a locally distributed multiple computer, has a variable number (up to 32) of six different types of processors, some of which can be redundant, closely coupled into a single system. The processors cannot stand alone. The computer is driven by a hierarchical distribution of operating system functions.

Nexos has a joint development effort with Delphi Communications for integrated office systems. No products have been announced. Nexos has also acquired the European manufacturing and marketing rights for the Delta 2 computer.

For non-typists

The approach being taken by Nexos is particularly important in Europe. "While it may be acceptable to put CRT terminals with keyboards on the desks of middle managers in the U. S.," Ellis says, "it won't work for the average European middle manager. In the U. S. you already have a critical mass of those managers who have been exposed to terminals and can type, at least minimally, but not in Europe. It would probably be exaggerating to say that 5% of middle managers in Europe can type." If the manager cannot or does not want to type, then how can he add his comments to a computerized message displayed on his screen? He will add what Ellis calls a "voice note," which gets digitized and distributed with the text message (and perhaps also an image message) within the network.

Governments in several Western European countries are sponsoring and investing in programs for office automation. For example, the French government is investing at least the equivalent of $250 million to develop an electronic office equipment industry. The Swedish government, through Televerket, the country's telephone company, has a policy of encouraging office automation and has been conducting an experiment for several years, called Office 85, that is unique in Europe. Some of the participating companies have been Philips, Telefon AB L M Ericsson, Stockholm, and Xerox.

Fujitsu America Inc.'s Word Machine terminal for IBM and IBM-compatible systems and the companion application software from Fujitsu running on the mainframe deliver a combination of office services. The package includes word processing, electronic filing, message and document distribution, and data processing.

The term office automation is somewhat misleading. The integrated electronic office systems do not replace office workers. Rather they perform functions that can increase the productivity of all in the office—from clerks and secretaries to top management—by assisting with mundane tasks that must be done every day. Much of this work involves handling information in large quantities, in forms such as the written word, numerical data, and voice messages. The goal of electronic office systems is to manage this information quickly and efficiently freeing the office worker for more thinking and decision making.

Delegating the details

The machines can gather, file, store, process, retrieve, and move information. They can perform most of the details of information sharing and delivering messages—getting the right information to the right place at the right time. This is the most time-consuming office activity, so automating these functions will improve productivity the most.

In so-called word processing, the actual typing of letters and documents is a small part of the picture. Estimates have put the cost of typing at only a little over 1% of the total white-collar labor costs (see Fig. 3). Looking for information, sending or receiving messages, getting signatures and approvals, mailing, and playing telephone tag takes up most of the time. Systems to aid in these areas also offer great potential for saving and productivity.

The telephone, the typewriter, and the copy machine have improved office productivity in the past, but new tools are needed. Computers—ubiquitous in data processing and factory automation—must address mundane office tasks like the following: electronic message service; electronic filing and retrieval; printing and copying; and integrating information from analysis, modeling, personal computing, and data processing into formal reports and informal messages.

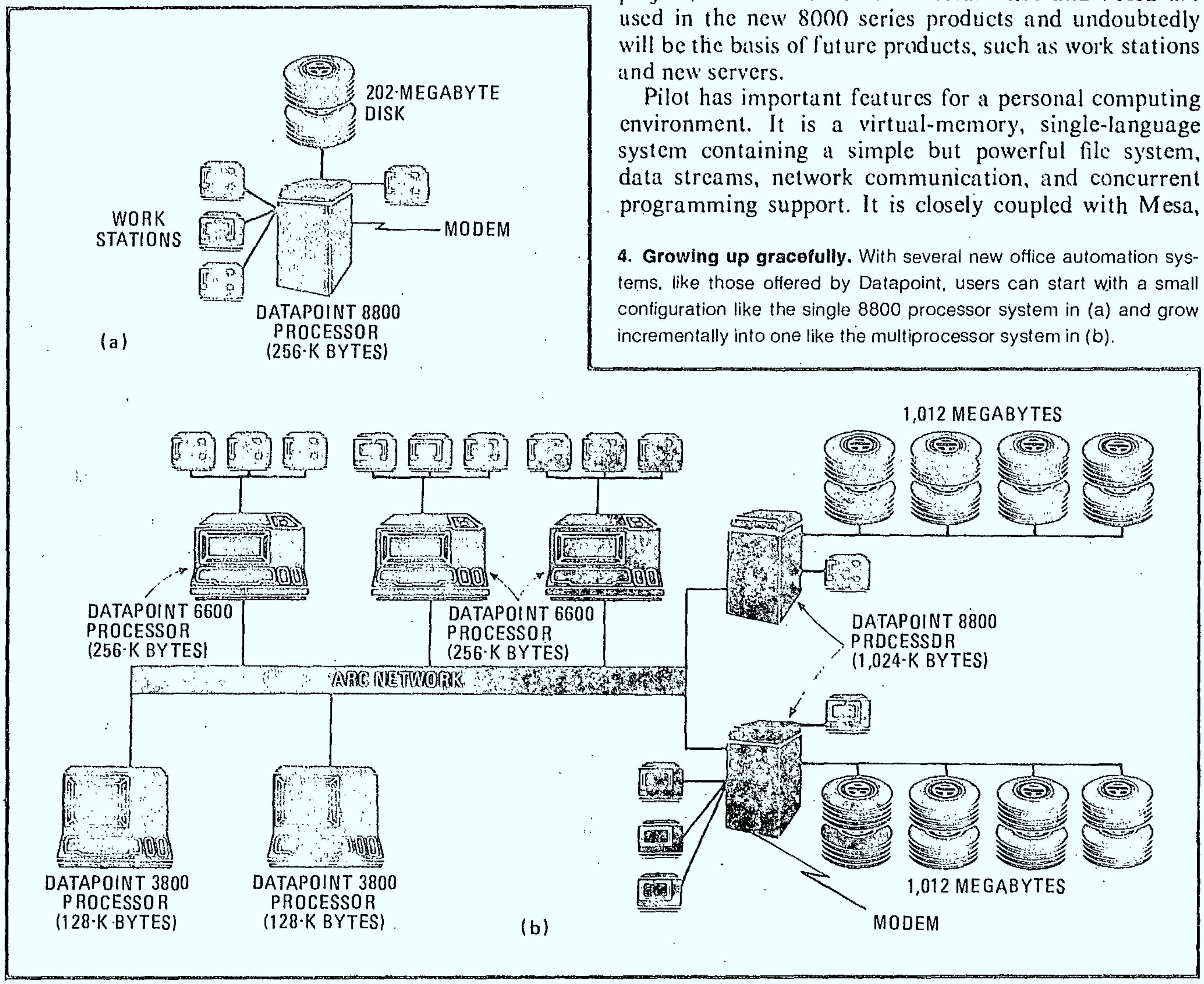
Advanced operating software such as Xerox's Pilot operating system, the Mesa language, and the rest of the tools in this powerful programming environment make highly integrated electronic office systems possible. This programming environment and the operating features of Pilot enable Xerox to offer products in an integrated office system like the one it announced in December and will permit it to offer quick and cost-effective enhancements as well.

Xerox spent about four years developing its software base for office systems. Its goal was to apply computer science to office automation. "Computing, in the strict data-processing sense, has been almost unaffected by computer science. But that study's techniques are the fundamental principles needed for office automation," according to David Liddel, vice president and general manager of Xerox's Office Systems business unit.

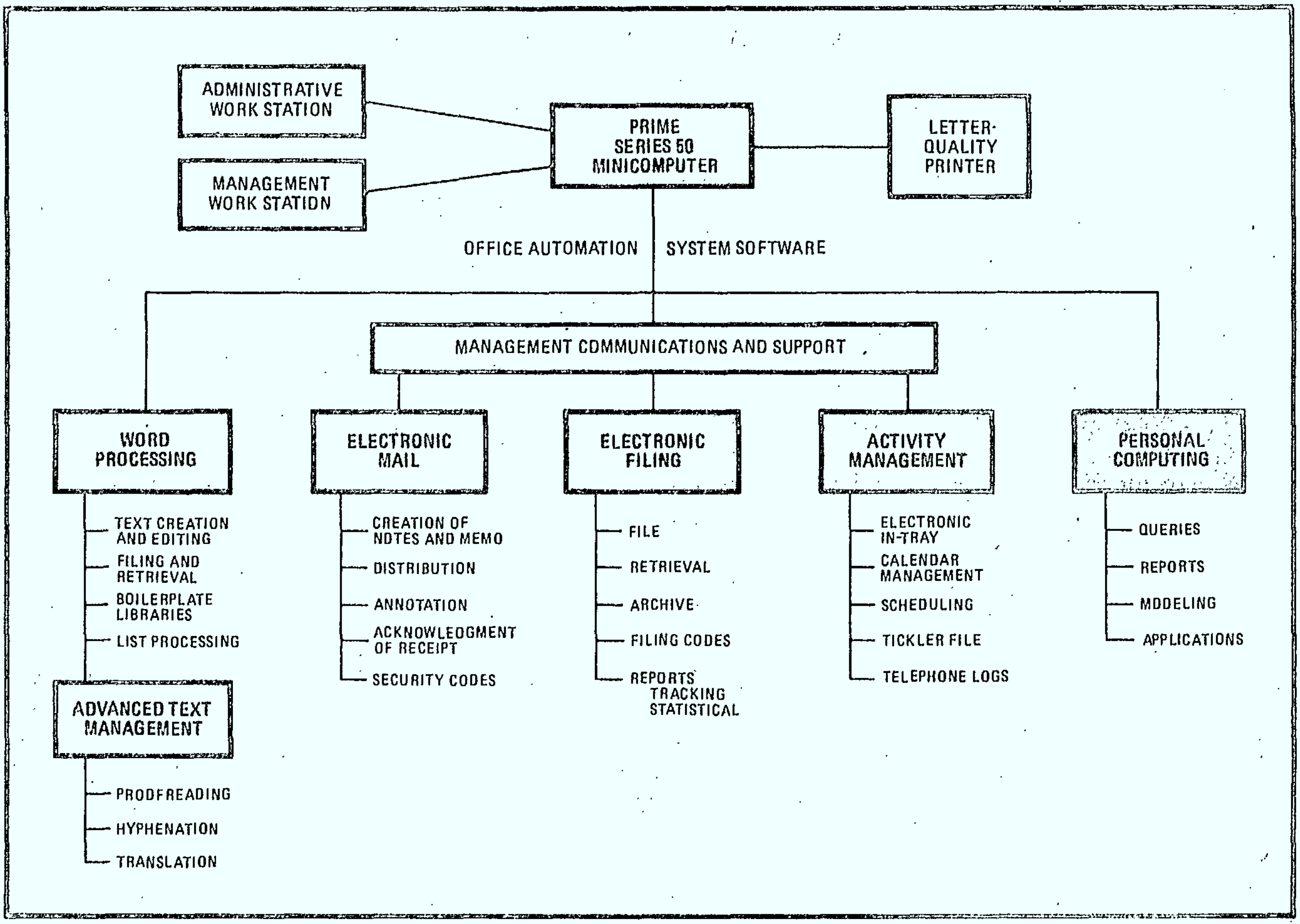
What is different about the Xerox approach? "Well, we took networking, a 10-year-old notion, and applied the concept to powerful personal computers at each terminal," says Liddel. Then, more significantly, the firm looked at software from a different perspective. "We took the idea that software has a long life—it transcends hardware life—and developed some to provide a system software development environment for production of modular, long-lived application software that would be hardware-independent. With its rapid development cycles, the hardware for these applications could be redone every few years and we would use memory instead of logic wherever possible."

The projects at the Xerox Palo Alto Research Center and their Office Systems Business Unit development group, also in Palo Alto, involved development of the Ethernet local networking scheme, the Alto personal computer, the Pilot operating system, and the Mesa programming language—though the Alto is purely an experimental computer. All these projects have been thoroughly tested within Xerox by the groups that developed them, using what they had already done to bootstrap further development—a method that helped make them more productive in pushing the system further. The work has also been tested at over 1,500 other Xerox offices (all interconnected with Ethernets) and in several large test installations outside of Xerox, including the Boeing Co. in Seattle, Wash., the U.S. Congress, the Office of the White House, and Sweden's Office 85 project, which included AB Volvo. Pilot and Mesa are used in the new 8000 series products and undoubtedly will be the basis of future products, such as work stations and new servers.

Pilot has important features for a personal computing environment. It is a virtual-memory, single-language system containing a simple but powerful file system, data streams, network communication, and concurrent programming support. It is closely coupled with Mesa,



4. Growing up gracefully. With several new office automation systems, like those offered by Datapoint, users can start with a small configuration like the single 8800 processor system in (a) and grow incrementally into one like the multiprocessor system in (b).



5. Task force. Prime's Office Automation System software has many functions to help with the large variety of office tasks. It automates much of the information management for an office far beyond word processing and is oriented toward managers and professionals.

the system's only programming language. Now that it is economically feasible to dedicate a powerful personal computer to each user, Xerox decided to design a complete software system to optimize service to that user and also function as the user's representative in a large community of autonomous personal computers and other information resources.

The hierarchical virtual memory of up to 2^{32} 16-bit words is mapped into a large, essentially unbounded file space. At the Pilot level, the file system is a simple primitive for accessing large amounts of information in large files that have no recognized relationships. File structuring is left to applications programs. Mesa is a modular high-level systems programming language designed to work with Pilot. It has full data typing like Pascal; interfaces and communications features that support the separate development and subsequent system integration of modules; and a source language debugger.

Laying the foundation

This kind of software development and operating environment, coupled with powerful microcomputers and a high bandwidth network, lets Xerox offer a series of compatible products that can serve as building blocks for a user beginning an office automation system on a small scale and building it incrementally, up to large completely integrated systems.

Like Xerox, Datapoint has invested many years and much money in developing and testing the software needed to evolve the integrated electronic office. But unlike Xerox, Datapoint has a substantial customer base using fully commercial products functioning as integrated electronic office systems that it has introduced over several years. These products, interconnected through its four-year-old local network ARC, represent several stages in the evolution of integrated office systems. The latest additions to the Datapoint systems came last fall. They include the flexible, multitasking, resource-sharing RMS operating system; a content-addressable data-access method, Associative Index Method (AIM); and a new processor handling 1 million instructions per second, the model 8800.

Also taking the approach that software is long-lived whereas hardware tends to be the opposite, Datapoint engineers designed RMS for a 10-to-20-year life. It is an advanced operating system with flexibility at the user program side that isolates the processor-dependent part in as small a module as possible. The nucleus, which allocates resources and performs controlling, monitoring, scheduling, and dispatching tasks and activities, is a relocatable library file. For RMS to run on a new Datapoint processor, only the nucleus library needs to be changed—the rest of RMS and all application programs remain untouched.

Bringing data-base management up to date

Like many other software solutions of computer science origin, data-base management systems were developed for large mainframe systems and tend to be elegant but inefficient. But with larger and larger amounts of data being kept in office systems, much more efficient data-management techniques will be needed. Enter a new concept: the data-base machine, which implements a proven software solution in specialized hardware and microcode. The machine offloads the data-management function from the central processing unit and puts it in a special processor between the CPU and the disks, much as the communications processors, or front-ends, took the communications load from the CPU.

This hardware implementation of a software solution from computer science, in the form of a relational data-base management system, may be applied to distributed, integrated electronic office systems. A new company, Britton-Lee Inc. of Los Gatos, Calif., is now delivering the first test units of the IDM 500 data-base machine—an ideal component for addition to medium-sized and large integrated office systems as a central file system and central store for an electronic message service.

The IDM 500 is a Z8000-based data-base processor capable of processing .3 million instructions per second. It interfaces easily with the processor in an office system network through a standard IEEE 488 bus on one side and with any standard storage module disk drive on the other. The key to its effectiveness is its ability to do the data-management processing on the disk byte stream in real time at the disk speed. For larger and faster disks, a data-base accelerator option—a hardwired emitter-coupled-logic–based microcoded processor with a 100-nanosecond bus—is available for an additional $10,000. Optimized for data-base processing, it can perform at an incredible 10 million instructions per second. The basic IDM 500 costs $50,000. Britton-Lee is working on a second model, a scaled-down version that will be priced in the $15,000-to-$20,000 range.

The system is somewhat like a super traffic cop. One of its key functions is organizing independent processes and all the traffic among them. RMS breaks the computer apart at the transaction level so users and user programs can define the system environment at the time the task is defined. For applications such as office automation, it is not possible to plan the system environment in advance and build a fixed system to perform the predefined job because no one knows in advance what the tasks are going to be.

One of the major challenges in the development of RMS was managing the traffic among tasks. The system had to be designed so that the traffic could move smoothly, quickly, with no bottlenecks or locks among a great many processes requiring resources that can be located anywhere in the network. This took several years of work, point out company officials.

The multitasking and partitioning is general. Interprocess communication is made through the network protocol. Two programs can communicate with each other on the same processor or on different processors; they can also be on the same processor one day and on different processors the next without changing any software. Multitasking and interprocess communication is done through Unix-like pipes; but the RMS pipes are more general and flexible. RMS removes task interconnection and partitioning from processor dependence—there is no longer a direct processor-to-partition correspondence.

The capabilities of RMS combine with those of the 2.5-megabit-per-second Advanced Resource Computing network and processors and terminals of varying capabilities (including the powerful new 8800) so that every terminal, intelligent or not, has access to every function in the net or any service connected to the net. For example, a black box supplying a new service like an ARC Communications and Emulation software package that emulates an IBM 3270 communications display terminal can be installed in an ARC network processor, and immediately every terminal can look like a 3270 to an IBM computer system.

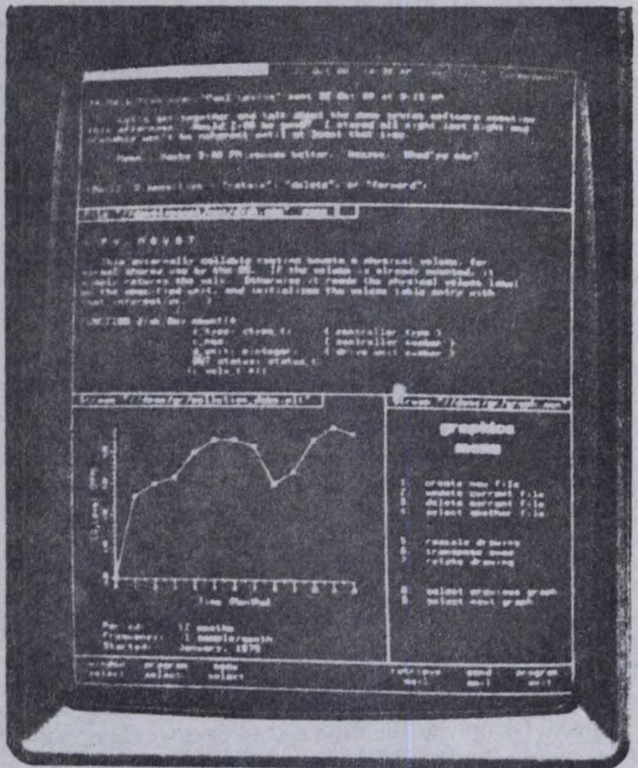
Most importantly, effective office systems must maintain flexibility in reorganizing network resources to define a task only at the time it is to be done. Datapoint's Associative Index Method system for information retrieval creates the index when the request is made. No fixed indexing structures have to be created when the information is stored. When data is stored, the criteria or combination of key words the future recovery of that information will require is unknown. The person or the program who will request recovery is usually also unknown. AIM provides a flexible information retrieval resource for an integrated office system.

Starting small

The compatibility and integration of Datapoint products—two of Datapoint's specialties (two others, also important, are good access methods and good local distribution systems)—let customers start their office system very small, add to it in small increments, and build it into as large and complex a system as they need (Fig. 4).

Prime Computer has taken a different tack. It built its complete, highly integrated Office Automation System on its Prime 50 Series multifunctional 32-bit superminicomputer systems. Using the extensive software base and the Primenet networking of these systems, Prime developed office system software for managers and professionals in large companies, as well as for the secretaries and clerks. For the managers, the system goes well beyond word processing, combining electronic mail, correspondence management with filing and retrieval capabilities, an electronic in-tray, calendar management, appointment scheduling, and a tickler file. It also contains an advanced text management system with multiple dictionaries for proofreading (Fig. 5).

Each user has access to two modes of operation—the office automation mode and the data-processing mode. The file structure and data-access methods are common and there is a function to move files back and forth between the two modes. In the data-processing mode, the user can access all Prime data-processing languages,



apollo computer

6. Many faces. The screen of the Apollo Computer bit-map display is divided into as many subscreens as needed to display the operation of all the concurrent processes. The screen shown has six areas: one across the top, one along the bottom, and four in the middle.

applications, and communications functions, including financial modeling and data-base management systems. These give a kind of personal computing facility to help management and workers use their time better. Prime's concept of effective office automation is similar to that of other leading companies, including person-to-person messages, better management communication, personal computing and information retrieval, and access to the company's data-processing functions, with word processing taking a diminished, but still important, role.

Easy for executives

The company's manager of office automation products, Peter J. Schlegel, says that "management and professional people will accept and welcome terminals at their desks once they see what they will do for them as part of an integrated system, especially in electronic mail and personal computing capabilities." Prime's management, all the way to the top—including Kenneth G. Fisher, president and chief executive officer—makes effective use of the in-house office automation system.

Most companies will automate offices incrementally, and a terminal on every desk is a long way off. However, the trend is evident, and the coming desktop terminals may very well resemble the experimental terminal being developed and tested at the Electronic Office Systems group of Northern Telecom. This terminal looks like a call-director telephone but has more buttons, a small display screen, and a pull-out alphanumeric keyboard. It is connected to a PABX such as Northern Telecom's SL-1 just as if it were a telephone—which it is, and much more. It accesses systems for message sending, meeting scheduling, word processing, filing, business system modeling, timesharing, and data-base management.

The use of PABXs and existing two-wire telephone cabling to carry and switch data as well as voice is an example of another beginning trend. The NTI experimental terminal, which the company declines to photograph for publication, is a telephone with a standard handset as well as a full-function terminal connected to the world through one two-wire cable. This trend, however, will not make high-bandwidth local area computer networks obsolete. These will still be used where the terminals are powerful personal computers in an integrated resource-sharing system requiring much broader bandwidth than the two-wire cable can muster.

Also for OEMs

Apollo Computer and Convergent Technologies are also offering distributed systems with many advanced architectural software and hardware concepts that could be used by OEM companies as a base for automated integrated office system for the 1980s. These systems have distributed functionality, modular expansion, and a good software development environment, like the complete office systems of Xerox and Datapoint but without the office automation application software.

The basic features of the Apollo Domain system are a dedicated central processing unit with a high-speed bit-map display for each user; an integral high-performance local network; a processor-independent high-level design of virtual memory, global network address space, operating system and languages, network protocol, and standard multibus I/O; and use of advanced hardware technologies such as VLSI CPUs and Winchester disks.

The bit-map display of the Domain system, as in the other systems that have it, is a flexible, effective interactive user interface. Different windows on the screen keep the user aware of what is going on in the various concurrent processes in the system. The display system has a bit-map memory in a square array of 1,024 bits on each side. Of these, 800 by 1,024 bits are constantly refreshed on a bit-map cathode-ray-tube display. The remaining 224 by 1,024 bits store a variety of character fonts and symbols. A hardware bit mover within the CPU can move a rectangular area of any size from any place on the screen to any other place on the screen at a rate of 32 megabits per second—"fast enough so that displays can be switched as fast as TV programs can switch cameras," says David L. Nelson, vice president for systems development at Apollo.

The display memory and program memory are on separate buses. But they share the same address space, so the CPU can instantaneously access display memory and alter its contents. The bit mover can move rectangles from display memory to program memory, where the CPU efficiently performs operations on displayed information such as an exclusive OR on two or more graphic representations. Then the information moves quickly back to the display to show the resulting graph. The CPU can access program memory, the display memory can refresh the CRT display, and the bit mover can be moving rectangles around the screen or into or out of program memory, all in parallel and without interference.

Because of this parallelism and the Domain operating system, many concurrent programs can be executing for each user and each program activity can be displayed in an independent rectangular window on the screen—a facility that could be called virtual terminals—as seen in Fig. 6. Apollo calls the windows pads, because they are like pads of paper with one page visible at a time. The multitasking, multidisplay Domain system allows several pads to be "on the desk" at one time. The user environment at the screen is a three-dimensional volume: 800 bits across, 1,024 bits vertically, and as many bits deep as needed.

Convergent's computer architecture is also based on the concept of transferring intelligence from the customary CPU to highly intelligent distributed work stations.

The Convergent system has a desktop minicomputer for single users networked with other work stations and servers and powered by an advanced "premier" 16-bit operating system. The real-time, multitasking CTOS operating system is a set of processes communicating through a precisely specified message-passing protocol. "Because it is message-based, the operating system can be distributed over the network," says Ben Wegbreit, vice president of sales and marketing and designer of the operating system.

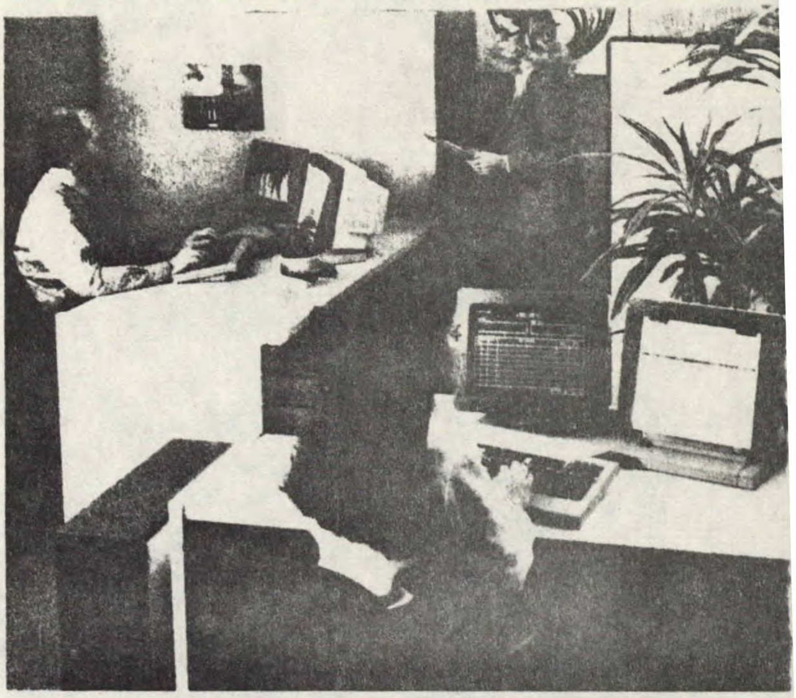
Making the connections

CTOS was planned from the beginning to be distributed over local and, eventually, long-distance networks. The distributed operating system is like a spinal cord to the collection of single-user minicomputers that make up the system. "We have really distributed the operating system," says Wegbreit.

Though the hardware technologies used by Convergent Technologies will change, the operating system architecture will remain stable. Software supported by the operating system will remain compatible across the product line and across time. The software base can evolve and grow while old software that is useful continues to serve unchanged.

The Convergent family of systems will offer a network consisting of work stations with one minicomputer, one CRT display, and one keyboard for one user; the CTOS operating system; high-level languages (Cobol, Fortran, Pascal, and Basic); a data-base management system; and a data-communication foundation. OEM companies and large end users will supply application software.

When asked why they developed this type of system, Allen Michels, Convergent's president and cofounder, indicated that it was to satisfy the public's voracious appetite for computational and informational power. "Look, for example, at the big demand for Apple computers and the IBM Displaywriter." The Displaywriter, an entry-level, stand-alone word-processor system announced by IBM in June of last year, is now, according to industry sources, in a nine-month order backlog. More and more users are demanding that higher rates of valuable information be made available in various forms, such as business graphics in almost real time.



7. A boon in the office. The complete personal minicomputer for office use from Convergent Technologies is a three-piece desktop arrangement of keyboard, screen, and computer with lectern face. Disk drives are in floor-standing cabinets that fit neatly beside a desk.

"A second trend, complementary to this computational voracity, is the plummeting price of computation," says Michels. Convergent's logical conclusion was to put big computational power right on the desk.

Its desktop minicomputer is packaged in an ergonomically designed three-piece system. It has a rotating and tilting CRT display, a detached keyboard, and a lectern enclosure, with clips for holding documents, that houses the processor electronics (Fig. 7). It uses a small amount of desk space and creates a logical triangular relationship between the operator's eye, the display, and the lectern, Wegbreit points out. For a minimum of desk space, one model comprises simply the display and keyboard for the desk, with a floor-standing enclosure for the electronics.

The market outlook

Most analysts agree that the market potential for office automation is very large. It is difficult, however, to find any two observers who agree on the definition of the market. Strategic Inc., the San Jose, Calif., market research firm, in a report released last November on local area networks, has based its definition upon what it considers the dominant long-term technical solution to office automation—the distributed-control local networks with intelligent devices attached.

The report projects that this market, including that for the attached intelligent equipment, will reach $200 million by 1985 and $1 billion in 1990. It goes on to say that less than 2% of the potential market will be penetrated by 1985 and 3% will be tapped by the end of the decade.

According to other sources, the word processing market will be close to $1.5 billion and the small-business computer market may be about $3 billion in 1981, but these two markets overlap considerably. □

Portable software for electronic mail makes it hardware-independent

Word processing and data-base management add to the message system's usefulness

by John M. McQuillan and David C. Walden, *BBN Information Management Corp., Cambridge, Mass.*

☐ Advances in digital equipment design, large-scale integration, distributed processing, and programming languages are providing local and nationwide, private and public data networks with communication capabilities unavailable only a few years ago. The latest of these developments is the first computer-based message system (CBMS) capable of running on virtually any computer or terminal. Called InfoMail, it is an application software package from BBN Information Management Corp. designed to work on already installed computer bases, ranging from the single host with single or multiple applications to the multiple host and all types of coaxial cable and fiber-optic local networks.

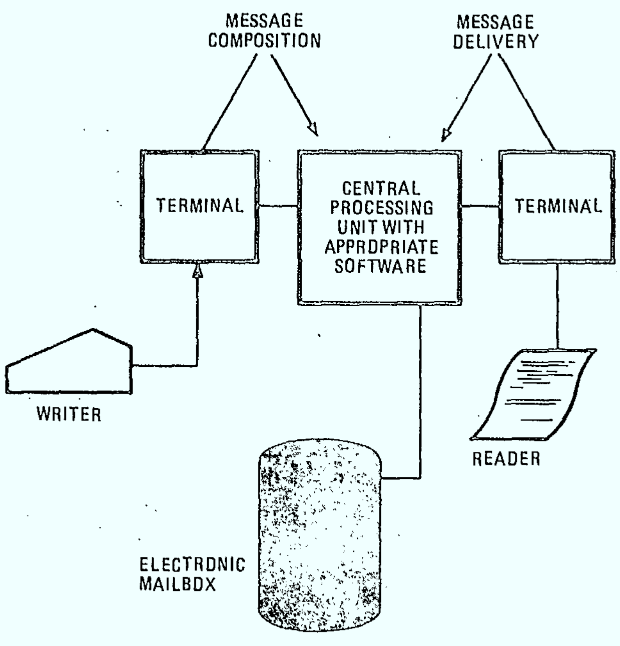
A CBMS is essentially an electronic mail system that also incorporates word-processing capabilities and data-base management for storage and retrieval of information. This integration of electronic mail with the word and data processing so necessary for the industrial research and development laboratory, factory, or office of the future can save hours of time for its user. It is also of interest to original-equipment manufacturers who are involved in the various forms of local networks, in distributed-processing work stations, terminals and computers, and in word-processing gear and software. These suppliers need to know how a hardware-independent message- and data-handling system functions so that they may incorporate it, or similar software packages of their own design, in their equipment. Alternatively, they may wish to make their gear as compatible with InfoMail as possible.

InfoMail may be thought of as a kind of electronic mail, although it is more than that. Electronic mail is a catch-all term for many different kinds of message-sending technology, ranging from facsimile to communicating word processors to telex systems and now to computer-based message systems (see "A long time coming"). Even with this broad range of technologies, it is possible to define electronic mail as simply any electron-

A long time in coming

The computer-based message system, or CBMS, owes its existence to the store-and-forward message-switching systems that were introduced in the early 1960s and form the basis for telex and TWX technology. These systems computerize the store-and-forward process but offer relatively poor user services. For example, users must manually check the reliability of the messages as they come in, number them, and log them. The systems have a limited editing capability, and a complicated approach to addressing other users—factors that today's computer-based message systems handle automatically.

InfoMail, BBN Information Management Corp.'s portable software product for sophisticated electronic mail, was developed as a result of parent company Bolt Beranek & Newman Inc.'s experience on the first packet-switching network, Arpanet, where programming is dependent on a specific central processing unit. Then in 1971, the first network-oriented CBMS was installed on several Digital Equipment Corp. PDP-10 computers in the network. This message system, though primitive by today's standards, was successful. It led to a second and finally third generation of CPU-dependent software dubbed Hermes. This is running at 15 Arpanet installations, supporting several thousand people.



How much does it cost?

If the InfoMail computer-based message system (CBMS) software package is installed on an in-house computer system, the one-time license fee is in the range of $20,000 to $75,000. The exact amount depends on the computer and the capabilities needed. An adequate level of computer power and enough terminals so that the user population has ready access is assumed to be in place.

A rule of thumb is that a medium-sized mainframe computer can support several hundred CBMS users. With such an installation, senior-level users will have their own terminals. More junior CBMS users will share terminals with one or two others.

The overall cost (not counting labor) of a system of this type is estimated by sources independent of BBN to be in the range of $0.50 per message. This is a low per-message cost and compares favorably with the cost of alternatives such as memorandums, telephone calls, and telex messages. However, the real advantage of CBMS lies not in the cost but in the time saved and the increased capabilities for meaningful and accurate communication.

ic system for transmitting information from a sender to a receiver in the form of a message. Like many such systems, therefore, InfoMail uses computer networking to assist in message delivery. But unlike them, it is also a computer-based message system (CBMS)—one that helps compose and store messages in electronic mailboxes assigned to each end user.

It therefore adds word processing to assist in message composition and data base management for storing and retrieving information in the electronic mailboxes. InfoMail provides these services plus the networking at a cost estimated to be 50 cents a message (see "How much does it cost?" above).

Documents, files, and forms

To assist in message composition, the InfoMail software has features dubbed documents, files, and forms after the actual inputs with which each is concerned.

In InfoMail, any document can be referred to electronically as an ordered set of named fields of information. For example, it may have fields of information labeled "date," "to," "from," and "subject," whereas other documents such as customer orders might have fields like "part number," "order number," and "quantity." Sometime in the future, a CBMS will be able to send and receive documents in which some fields contain information that is not even in text form. For example, document fields might include voice messages, facsimile pages, or even computer programs to be executed when the message is received.

Documents are stored in a data base to which InfoMail gains access by a hash key. A hash key resembles an address and consists of a unique document identifier or the combination of the identifier and a field name. Thus, even a randomly chosen document may be accessed quickly.

Documents are stored in the computer with data structures that permit other fields of the same document to be found quickly once any field is found. Thus, the system can access a random list of documents or all the documents within that random list having a common field.

A single systemwide data base of permanent documents is shared by all users of InfoMail. In such a setup, the space needed for document storage is kept to a minimum, documents are transferred rapidly from one user to another, and communications overhead is reduced. Moreover, a single user may easily store copies of a given document in several of his files.

A CBMS like InfoMail must also support files for all of the different types of information that can be sent in a document. In InfoMail, these files consist of ordered lists of document identifiers, plus the documents, or identifiers of other files, plus the files. Data-base storage by the CBMS means that the files may efficiently be created, retrieved, modified, and deleted. Documents and files may also be inserted and deleted at any position within a file that contains them. Because files may contain other files, InfoMail supports a hierarchical file structure, which models conventional paper-handling systems. Copies of the same document may be in several files since this, too, models the conventional approach.

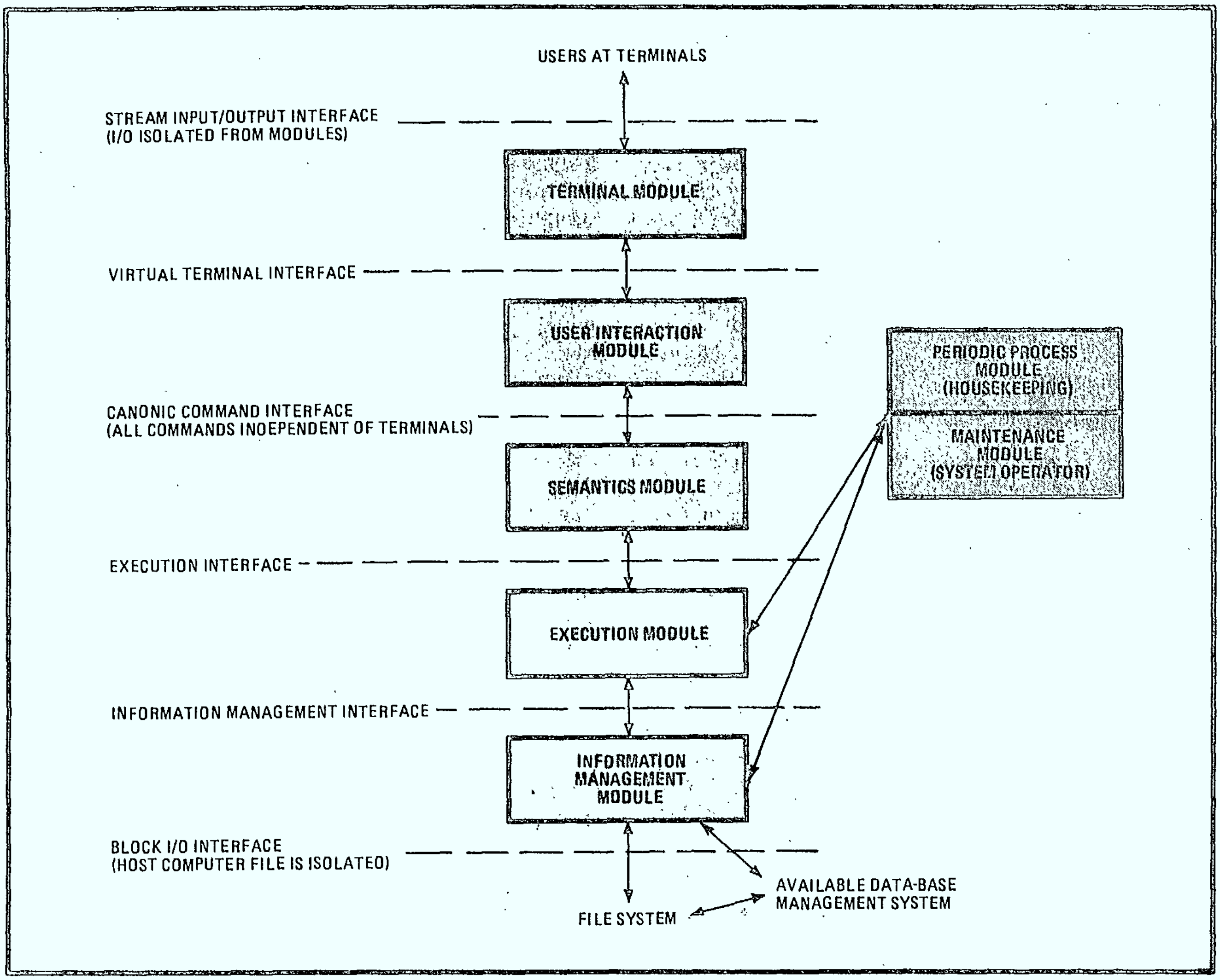
The final building block to go along with documents and files is a forms capability. Software forms are the electronic equivalent of the fill-in-the-blank form that is common for many applications such as engineering change orders and requisitions. InfoMail provides a forms capability as easy to use and as general as making up a form on paper. In the future a "smart" form will be developed by BBN. It will have the intelligence for handling the information it contains—for example, by asking different questions depending on the answers it has obtained to earlier ones.

Forms are a general mechanism for entering data into documents or creating data (for example, by collecting statistics) or for displaying the contents or partial contents of documents. For instance, when a user creates and sends a memorandum by specifying the "to," "subject," "date," and "from" fields and the body of the memorandum, he or she is filling in a form.

In addition, the forms capability makes it possible to vary the display of documents. As a result, it is easy for the user to reformat documents—for example, by printing only a few of the fields in each of a set of documents. The same capability also transforms documents into other documents. For example, with it a user can add new fields to a set of existing document.

User to user

Besides assisting the user in message composition, the CBMS must be able to help in message delivery by optimizing communication between users. For a user to communicate with another person, any document to be sent must have some address fields ("to," "forwarded to:" or "cc:"). Specific addresses in address fields may be the name (or alias) of an individual user or of an address list or of a file user (a file tag). Though this last



1. Multiple modules. There are seven software modules in the InfoMail computer-based message system. These are written in Ratfor and are designed with appropriate interfaces for operation independently of the type of computer or terminals used in the communication network.

feature is not yet available on InfoMail, ultimately InfoMail will be able to send documents to individuals, address lists, files, and combinations of these.

There will be no distinctions apparent to the user between addresses for individual users, user aliases, address list names, and file tags. Thus they may be mingled at will in the address fields. However, interuser communications does make a distinction between the physical address (the computer in which the user's mailbox is stored, plus his account name or number there) and the user name. This later label may be the person's name and/or other identifying information like a department number. The software simply looks up user names in its directory to convert them into physical addresses. As a result, two users may exchange messages without knowing where each other's mailbox is located.

The process interface

In some instances an InfoMail user may find it desirable to interface other software to the CBMS directly. For example, he may have a program that prepares a monthly summary of a large body of (say) production data that is sent to a number of other persons. In one approach, the user's program creates a computer file, turns it into an InfoMail document, and then sends that document to the distribution list. However, if the user's program automatically produced the summary, the program could instruct InfoMail to send the document automatically to the distribution list. In this case, what is known as a process interface gives external programs access to InfoMail. With this interface, a program can call up as subroutines the various commands the user normally types in.

Networking arrangements

While handling documents, files, forms, communications between users, and other program interfaces, the CBMS must, as mentioned earlier, operate in many different computer architectures. Of all these possibilities, the most common in major corporations is one that has a number of different long-distance and local networks provided by different vendors. In some cases these overlap and interconnect.

The installation of the CBMS on a number of separate computers linked by communications lines raises the question of computer communication. The InfoMail procedure is based on what is called an application protocol for exchanging messages—a protocol that is independent of the physical path that connects the two computers, which may be a direct line.

The layered approach to computer communications, in which application software is independent of the physical mode of communications, is by now universally accepted as a necessary design principle in this area. Well-known examples of such layered communications protocols include the International Standards Organization's Reference Model, the X.25 of the International Consultative Committee on Telegraphy and Telephony, and International Business Machines Corp.'s System Network Architecture (SNA).

Internal modules

InfoMail's application software system comprises a set of modules that provide all the software paths between a terminal and a controlling computer. For example, the terminal module (Fig. 1) is an operating system for data or message entry. It controls the user terminal and interacts with the human operator through what is called the stream I/O interface. Through a virtual terminal interface, the terminal module communicates with the user interaction module.

The user interaction module accepts user commands and parses them (breaks them into computer-usable components) while supplying default arguments (ambiguity decisions) where possible. In addition, it assists the user in a number of ways—it permits him or her to edit and repeat incorrectly typed commands, provides lists of command options, and gives examples and descriptions of commands.

The user interaction module interfaces with the user terminal and the user semantics modules. It also handles a standard set of terminal routines that isolate the rest of the InfoMail system from the idiosyncrasies of the host computer's I/O systems. This is one key to the CBMS's portability from computer to computer. Between the user interaction module and the semantics module, an interface passes commands that are independent of terminal type, syntactically correct, and in a highly structured format.

For its part, the semantics module takes care of user manipulation of the documents and files discussed earlier. It executes the commands the user gives and enforces the rules about what a user can and cannot do with documents and files. Furthermore, the semantics module handles certain defaults that are beyond the capability of the user interaction module.

The semantics module is coupled by the execution interface to the execution module. This module provides a number of important subroutines that can be called either by the semantics module or by the periodic process module. It includes subroutines for sending and receiving documents, editing documents and files, interpreting forms, and establishing compatibility with host computer operating system files. Many of the future CBMS enhancements that were mentioned earlier will be handled by this module.

What is Ratfor?

The high-level language Ratfor (for Rational Fortran) is one of the best known of a number of available Fortran preprocessors. A preprocessor shields the user from many of Fortran's deficiencies while keeping its chief advantages: Fortran is in widespread use, and high-quality compilers are available for it. Ratfor permits the Fortran programmer to use structured programming (commands such as while, for, if/else, switch) and long mnemonic variable and routine names. These facilities enable programs to be written rapidly.

The programmer's code, written in the Ratfor language, is translated into conventional Fortran code by a Ratfor preprocessor. From there, the code is compiled into an executable program by the available Fortran compiler. Although this makes program compilation a two-step process, experience has shown it is more than worth the extra cost in terms of shorter development times, easier program maintenance, and better programmer morale.

Portable software. The chief advantage of Ratfor software for computer-based message systems is program portability. There are substantial differences in different Fortran compilers and in the underlying machine characteristics. Worse yet, Fortran programs may take advantage of special machine characteristics like floating word or character size that may not be easily transferable.

Users of Ratfor have aimed at software portability from the outset. They have chosen standard versions of the language and avoided features that cannot be accommodated uniformly by the different Ratfor-to-Fortran preprocessors. Furthermore, since Ratfor can be used as a system programming language, Ratfor preprocessors are written in Ratfor itself, easing the bootstrapping process to new computers. And finally, some Ratfor preprocessors produce output in other languages such as Bliss or PL-1, which of course signifies even greater possibilities for Ratfor portability.

Features. One of Ratfor's major features is that it passes many lines of the source program (assignment statements and subroutine call statements) directly through to Fortran without translation. Thus, if the user wants to maximize portability, he must avoid using the most machine-dependent Fortran statements (input/output, character handling). They must be handled with calls to appropriate subroutines and functions.

To date, Ratfor has not dealt cleanly with Fortran's deficiencies in string handling and pointer manipulation. The user expecting to write high-performance portable systems programs in Ratfor will have to adopt appropriate data structures and programming conventions to work around these problems.

Fortunately, it is easy to learn about Ratfor. Major system programs have been written in Ratfor (and other Fortran preprocessors) by a number of groups over the last several years. Ratfor and its use in creating portable software is discussed in "Software Tools," edited by Brian Kernighan and P. J. Plauger and published by Addison-Wesley Publishing Co. in 1976. Also concerned with Ratfor is the advanced systems group in the computer science and applied mathematics department of the University of California at Berkeley.

Why does electronic mail fail?

Some trials of computer-based message systems, or CBMSs, have failed. There are several reasons for this. If the computer is too slow, people will not want to use it. If the computer has too much downtime, people become discouraged. Certainly, if it destroys messages or loses files, they stop using it.

But the most common reason people give for not using a CBMS is that they are "too busy to use it." Yet a CBMS is designed to cut, not increase the communications burden. In fact, Bolt Beranek & Newman Inc. has determined that failure usually relates to some unhappy experience in using the system.

For example, engineers may have used the system and had a hardware problem, or they have made a mistake and have not been able to correct it. Moreover, they may not have had adequate training and introduction to the system, or may simply be afraid to try it. An equipment manufacturer planning to install a CBMS or an engineer-user who wants one in his office must remember to give beginning users enough help.

The information management module provides a database management system suited for a CBMS. In a sense, the information management module is the memory system for a hypothetical computer designed to manipulate documents and files. In turn, the programs that call this module can be thought of as the equivalent of the instruction set for the hypothetical computer. The information management module provides a highly structured capability for creating, retrieving, modifying, and deleting documents and files.

The information management module may be called by the semantics, the execution, or the periodic process module. It provides a standard interface that isolates the InfoMail system from the idiosyncrasies of the host computer file system, just as the user interaction module isolates InfoMail from the host system's terminals. This isolation from the host hardware is key to InfoMail's portability.

Two more

The periodic process module handles those InfoMail functions that are executed periodically rather than at the user's command. These functions are either short- or long-term. The short-term periodic processes include the transfer of documents between users and the polling of the interfaces in order to transmit messages between computers by InfoMail; these processes are attempted at some appropriate frequency. The long-term periodic processes include housekeeping of the InfoMail systemwide document data base and document retrieval from computer archives.

The last of the software modules, the maintenance module, runs manually as needed. It adds users to the system, changes the user directory, compiles new forms, and carries out other functions that must be provided by a system operator. Almost all the software in these modules is written in Ratfor, a structured programming language that a preprocessor translates into a standard version of Fortran (see "What is Ratfor?", p. 170).

Applications beyond just mail

Today it is highly feasible to organize a research and development facility, laboratory or office around a CBMS like InfoMail. Yet many companies have still to adopt the CBMS technology, and some have tried and failed (see "Why does it fail?" above). In a typical working installation, members of the technical and engineering staff use the CBMS for daily communication on their projects, for exchanging drafts of reports, and even for transmitting modules of software. Management uses it for project control, for work assignments, and for staying in touch with activities of the staff. Moreover, many professional staff members have terminals both in the office and at home, so the home can be used as a work place when necessary.

Manufacturers of original equipment can install a CBMS capability in their computers, distributed processing stations or networks, to create systems they then can sell to a wide base of customers. For example, in sales management a CBMS builds and maintains records of customer names and the dates of contact and follow-up by phone or mail. Sales personnel can construct these documents with the aid of a special form that asks for the customer's name, address, and telephone number and that can be updated to include the date and type of further activity. These files can then be used as the basis for future direct mailings. Local networks sold to business users may wish to incorporate such features.

Keeping track

Document management is another example of a CBMS application. For example, libraries keep track of the periodicals they acquire and other publications by means of documents kept on line in the CBMS. Likewise, legal departments can have litigation support systems based on CBMS documents.

Records management is ideal for a CBMS. BBN, for one, maintains its company telephone book in the CBMS. Many of the business records of the different operating divisions are also kept in this form so that they can readily be compiled and combined into reports and summaries of previous activities and current status. One group keeps track of its computer terminal inventory this way, according to purchase date, user, model of terminal, and account number. In short, there are many common business problems that can be solved by the CBMS approach.

In the future, a CBMS will make it possible to automate complex structured procedures such as the budgeting and forecasting process or the purchase requisition system. These are all activities that can be conducted semiautomatically by means of a sophisticated electronic mail system that distributes questions, gathers replies, and then organizes the collected information. Still other uses will develop as engineers become familiar with the advantages of a hardware-independent CBMS. □

DOWN THE YELLOW BRICK ROAD TO THE COMPUTERIZED OFFICE

Robert H. Epstein
AT&T Long Lines
Morristown, NJ

Based on talks given at the 32nd Annual Conference of the International Communication Association (Boston, May 1-5, 1982), the Association for Computing Machinery's SIG Conference on Office Information Systems (Philadelphia, June 21-23, 1982), and the World Future Society Fourth General Assembly "Communications and the Future" (Washington, D.C., July 18-22, 1982). Although generous in their support of this work, the author's company does not necessarily support the views expressed.

DOWN THE YELLOW BRICK ROAD TO THE COMPUTERIZED OFFICE

Robert H. Epstein
AT&T Long Lines
Morristown, NJ

Numerous attempts have bean made to design and implement computer-based office systems (CBOS) which would increase office productivity. Only a few have been successful. Many of the endeavors have been thwarted by the failure to express a design and implementation strategy or architecture indicating the purpose and growth plan for the system. Even when architectures have been used, the results have been less than expected because of the lack of a social component or layer.

This paper outlines some benefits of CBOS, examines the problems with current implementations, and suggests some recommendations for future consideration. Primarily intended for designers and implementors of the computerized office, this paper also should be of interest to scholars and CBOS users.

A Description of a Typical CBOS

There is no typical CBOS. In small offices (about seven or fewer persons) where one physical office embodies the entire organization, CBOS likely consists of a single-user word and list processor or a multi-user single processor performing these tasks plus some data base, accounting/payroll, special routine, and home-grown functions. As the "office" grows in size and/or number of locations, communications between processors becomes increasingly important (but is not necessarily done).

Large organizations have similar functions but perform them differently. These tasks are taken out of the mainstream of the office and put into centralized locations, such as word processing centers, or into environmentally controlled locations typically called data processing rooms.

Some innovative organizations, both large and small, have done more, using, however labeled, computer-based office systems or advanced office systems or office automation systems. These systems make available "what-if" calculation capabilities, messaging, calendaring, conferencing, text quality management, typesetting, graphics, and numerous other computer-based tools, and these are available to more information workers than the systems described earlier.

Although CBOS and specific tools may share the same name, their implementations frequently differ. First, the tools may look different. They may provide slightly different functions. Options available with one version of a tool may be not available with another. Also, each "office" probably differs in the number and types of tools made available to workers. The number of tools will vary based on the organization's size, resources, innovativeness, etc. Selection of appropriate tools for the organization will be based on availability, familiarity, cost, politics, need, and numerous other factors/1/. Finally, how the tools are used will also differ among organizations. Affecting use are such influences as perceived functionality, organizational culture, ease of access, and individual differences.

To repeat, there is no typical CBOS. Yet, there is a need to review the claims made about the computerized office in how it increases productivity, adds to the quality of work life, and makes an ailing organization healthy. While there is little doubt that the opportunity exists for vast improvements in how most offices operate today, each implementation of the computerized office must prove its own worth. Following is a brief review of some of the benefits and limitations of a composite of results of CBOS implementations each having used some or all the tools mentioned earlier.

Benefits

Mechanization of centralized services, such as word processing, mail delivery, information storage, and graphics and design, has resulted in performing these tasks more efficiently compared to the resources previously required. Although the introduction of computerized tools did not start the centralization process, they did facilitate it by increasing the ability to achieve local efficiencies.

Results of using innovative tools depends on the particular tool and implementation. "What-if" tools have not as yet received widespread use but appear to be significantly useful in those instances where they are put into the hands of decision-makers. Computerized messaging or "desk-to-desk electronic messaging" has been of benefit to workers who have terminals available at their primary work space/2,3/ and/or can delegate access of the CBOS to subordinates. The main advantage of computerized calendars appears to be the tracking and scheduling of time within groups. Each of the other innovative tools, likewise, appear to have benefits under specific circumstances.

Repeatedly, our studies of computerized messaging find managers reporting increases in manager-to-manager communication effectiveness, interpreted as "completeness, efficiency, and accuracy in analysis and distribution of information critical to organizational effectiveness"/4/. Certainly, a major benefit to both individuals and organizations has been knowledge gains. Depending on the particular individual or organization, the knowledge areas affected include the CBOS skill level, marketing insights, application and implementation knowledge, and increased awareness about the functions an organization performs.

Other opportunities for benefits exist/5,6,7,8/. Whether each opportunity for potential benefits of the computerized office is realized depends on the implementation conditions.

Limitations

Concurrently, there is a growing awareness that CBOS systems have somehow failed to reap the benefits claimed by some vendors, designers and consultants. As has been alluded to, there is little inherent in any of the computer-based tools mentioned so far that provides benefits regardless of implementation conditions. Following, we will discuss some of the limitations of CBOS designs and implementations where, it is suggested, these limitations are a result of failing to recognize the social or organizational aspects of office work.

It is rare for an organization to implement an entire CBOS package. They are too expensive, unproven, complex, etc. to be accepted as one complete and final package; they are subject to the same parameters of decision making involved in the adoption of any innovation as described by others/9/: relative advantage, compatibility, complexity, communicability, and, in particular, divisibility or trialability.

Also, there appears to be no one configuration that can match all organizational structures and needs. We have identified several ways in which user communities differ:

- geographic distribution
- population size
- installed base of equipment
- functions
- levels of performance
- physical environment
- budgetary constraints
- formal/informal organizational structure
- variety of social relationships
- level of CBOS support personnel
- segmentation of responsibilities.

Incompatibilities between CBOS's and adopting organizations have become especially salient during implementations. Problem areas have included, but are not limited to, training, documentation, deployment strategies, jurisdictional disputes, and especially, the inability to show positive cost justification.

Another example of "lack of fit or match" is demonstrated in how CBOS's are typically designed to handle the administration of systems. Administration includes such tasks as access control, accounting, software support, performance measurement, and others. When CBOS's are used by greater numbers of workers within an organization, these administrative tasks will spread beyond the responsibilities of one individual or department. Unfortunately, most systems were never designed to share the administrative functions (thanks to traditional

centralized data processing). As a result of this, numerous complications, such as computer naive individuals gaining access to potentially destructive "super user" capabilities, are surfacing. As more and more organizational functions are moved onto CBOS, this problem of "lack of fit or match" will significantly worsen.

Utilizations of CBOS have followed traditional practices. The use of these "new" technologies has been limited to the mechanizations of established rules and social relations. Most implementations have been made using new tools but to do old procedures. Rather, they should be garnishing up enough authority to suggest that new practices need to be implemented. Productivity enhancements, therefore, have been limited to those quantitative or incremental changes that can be made in the efficiencies of familiar practices. Significant opportunities for productivity increases cannot be realized until qualitative changes of organizational behavior occur. (And certainly, ailing organizations will rarely become healthy from the use of a CBOS without concurrent management redirection.)

For example, coordination of work hardly has been affected by current varieties of CBOS. First, in most implementations CBOS tools influence only a limited part of the total picture of office activities. Implementations were found to address only a few selected tasks in isolation of the influence on, or feedback from, other tasks in the worker's repertoire. Second, each information worker also performs work in concert with other workers, and these relationships between coworkers, for the most part, have been neglected in both design and implementation activities/10/.

In fact, organizational practices, communications, and elements of the culture (i.e., office objects) are rarely used in implementation strategies. We have seen CBOS "planned" use proceed from an unrestricted environment to where they tend to match the previous communication and authority structure of the organization. Gatekeepers have remained gatekeepers, bosses have remained bosses, data horders are still data horders, and those who previously enjoyed and practiced social communications continue to do so.

Although some individuals report certain gains in perceived efficiency and effectiveness, determining how these contribute to the "bottom line" of the total organization is extremely difficult. In small businesses, these local efficiencies may be more apparent and easily traced but in large organizations the effects are not obvious. Attempts to measure "gains" have typically come down to relying on subjective measures provided by users.

Also, local effects in large organizations may or may not be summative when viewed as organizational gains. It must be decided if what is being done is in accordance with organizational goals, not a duplication of effort, and not a "washed-out" effort in the composite view. For example, a manager being especially efficient at producing report X may not result in a contribution if his/her goals differ from or are in opposition to those of the organization. Even if goals match, a similar effort elsewhere would bring into question the worth of duplication. Finally, as the report travels from desk to desk in the organization, its impact--the manager's effort--may be totally negated.

Of all, the greatest limitation of current CBOS design and implementation practices is the means provided for interfacing or communicating with the environment. The environment is defined here as "those entities not initially conceived of as part of the system."

The first system and environmental "connection" problem is CBOS access BY users. We have found perceived physical ease of access more related to CBOS use than any other concern, human factors or otherwise. If a terminal is not at an information worker's desk, then he/she must go somewhere else to access the system. Even if there is a desk terminal, it may be used in a time-shared environment where the terminal is frequently turned "off" and thus, not "connected" to the main flow of work.

In addition, system definitions are so narrowly drawn as to isolate the CBOS from other activities in the worker's repertoire. For example, few innovative attempts have been made to send a "signal" TO users about a system condition when the users are not perceived as "using" the system. An example of this is a CBOS message service that only indicates a message is waiting when the recipient "asks" after "logging on."

Because of the entry level cost of most terminal devices (more than $500 each) and workstation packages (more than $3000 per user), the number of persons that can be served by a CBOS typically has been less than entire communities of interest. This results in the continued and additional use of the manual system(s) targeted for replacement. Duplication of effort is required because service is not universal.

Confounding the lack of universality are systems isolated from other corporate systems. It is not unusual to find minor technical or jurisdictional incompatibilities creating needless system boundaries. Whereas optical character readers, manual conversion procedures, and other mechanisms have been developed to "glue together" systems and the environment, these methods will cause future bottlenecks.

Although terminals and CBOS services may always be accessible, it is not enough. Services and/or applications should be tied to all other business activities, such as telephone use, goals, etc. When a CBOS does not have this form of "access" to all of a business's activities and functions, it is limited in its potential for increasing productivity and the quality of work life.

Mapping the Way: An Architecture

Design and implementation are the decision making processes of determining and selecting the operational parameters (technology and constraints) of a system. The concerns include, but are not limited to, specific features of the user-interface, hardware selection, and specific organizational responsibilities. A plan is established to determine the potential user community's experience with CBOS, the hardware that is entrenched, and the contributions required by various organizations.

Both design and implementation activities are based on an architecture. Whereas, traditionally, architectures have been used to organize the technical aspects of design, they can be used by implementors to plan and organize requirements and implementation.

> An architecture is the specification of the composite of views of a system free from the constraints of implementation and based on a complete set of principles that enable easy growth from simple (or now) to expanded (or later) views. It is layered for aiding the specification of various views.

Use of an architecture in the design and implementation of CBOS's will aid the inclusion of a social view. Determining the requirements for an architecture allows the incorporation of corporate and user needs and goals as the skeleton of design. It is planning rather than afterthought. As pressures for growth test the architecture, if well done, it will not be encumbered by initial implementation constraints.

Brooks/11/ wrote "The architect of a system, like the architect of a building, is the user's agent. It is his job to bring professional and technical knowledge to bear in the unalloyed interest of the user, as opposed to the interests of the salesman, the fabricator, etc." (p. 45).

Agents who understand the social and communication needs and behaviors of offices and also the organizations that occupy them can play a role in determining the highest levels of design of CBOS architectures.

Some Suggestions for Enhanced Productivity

Following are conceptual requirements for the design of a CBOS based on a design and implementation architecture. The requirements have been determined by taking a somewhat different and more "social" view. They are illustrated using a "corporate" or "organizational" perspective.

The Corporation as User

Up until now, the individual user has been the primary focal point for the designer and implementor. It is suggested that the corporation or organization should be given at least equal importance.

> A corporate view, in contrast to a user view, is one that reflects the goals and needs of the organization.

CBOS's should be acquired and implemented for meeting the needs of a company's short and long term strategies and objectives. This means determining the goals of the business and setting up plans to achieve them. Generic goals may include solving current problems, meeting legal and regulatory requirements, improving corporate decision making, interconnecting resources, seeking new opportunities for service, increasing productivity and revenue, creating improved products, etc. Methods for determining and implementing these are greatly needed.

One version of the corporate view suggests that the computerized office be the "computerized organization" and include the integration of workers (all workers who use business information, i.e., managers, clerks, order pickers, etc.), information systems, and procedures in a system architecture.

Besides traditional CBOS, the set of tools described earlier as "innovative," the computerized organization architecture encompasses all information conduits, mechanisms, and storage centers "owned" by the business. A partial list includes communication services such as phone, facsimile, and data links; mechanisms such as company operational systems, word processing, personal computing, and corporate and outside timeshare services; and stored information such as what is found in job-specific and large data bases, including libraries and data centers. Finally, the systems that run and plan the building facilities (i.e., energy, etc.) are integrated into this corporate view of CBOS.

Following are five requirements using this organizational perspective. It is beyond the scope of this paper, but each of these concerns at another time need to be interpreted using the individual and other social units as the "user" of consequence.

Modularity: How to Make the Shoe Fit

Whereas each requirement is aimed at the goal of providing individual communities of users a system that can be configured by the community for their particular functional needs in an affordable technological environment, modularity specifically addresses this concern.

> Module design is the segmentation of processes and structures within an architecture such that only one process or structure is contained within a module. Modules communicate with one another and can be configured to fit the particular requirements of an implementation.

Taking the CBOS administration example described earlier, modular design would allow for an architecture to be administered across a variety of organizational structures.

Beyond Hardware and Software: Roleware

In addition to software and hardware, roleware is available to develop a CBOS system.

> Roleware is the set of relationships between individuals in the computerized office resulting from the behaviors required by the use of the technology. It consists of: 1) job entities, 2) job responsibilities, and most importantly, 3) job role relationships.

An example of a job resulting from CBOS use is that of the "user analyst." This position evolved in the course of numerous CBOS projects as the result of both planned and unplanned job responsibilities/12/. The user analyst interfaces between the user community and the parties providing CBOS service. He/she understands community and end-user functions as well as how each uses the system. In a more active role (e.g., trainer and change agent) this person provides service support for each user assisting in the customization of the system for each job.

Roleware is defined by "jobs" not in isolation but relative to one another. For example, the subordinate's behavior influences what the boss does as well as the boss managing the subordinate. This view, in concert with the variety of tasks associated with a particular job, (such as the 60% of the time managers spend in meetings) leads to an expanded understanding of the how CBOS influences and is influenced by "office behavior." In other words, using an approach based on roleware includes: identifying what is office behavior, determining how a CBOS could aid job performance, examining the subsequent behaviors resulting from use of the CBOS, and deciding whether these behaviors are appropriate for a particular job and its associated relationships in terms of status, esteem, etc.

Proactive - An Attempt To Include What is Known

Organizational rules, both formal and informal, access and control of resources as well as other aspects of management control, and components of the organizational culture can be incorporated into a CBOS.

> A proactive system is the design of a system based on a model of the user, user activities, the user's environment and user goals so that interaction with the system is initiated by the system for the user.

In terms of the corporation as user, the proactive orientation would result from corporate needs. It would aid the following of formal procedures and "the way things are usually done" (subject to negotiation within and between organizations and individuals) by incorporating these into the "permissions" and "programs" of the CBOS. For example, the subsequent steps of an organizational approval process could automatically be carried out, or a new employee could be led through a "socialization" of informal procedures by using a proactive system.

The ability to change goals and have procedures and priorities subsequently change would allow the organization required to act quickly to respond at its capacity. In other words, a business needing to use all of its staff to meet the demands of a crisis or opportunity would be able to do so by changing the priorities of its goal structure, in turn, to immediately alter the input and resource conditions of each workstation or department.

Proactive designs also take what is known and incorporate it into the CBOS so that the system does not have to serendipitously learn to incorporate the obvious. The attributes of office objects, events, resources, etc. are likely candidates for incorporation into a CBOS.

Feedback Mechanisms

One method to provide both the organization and individual user with "data" about the usefulness of a CBOS is to build mechanisms into the CBOS that measure performance.

> Feedback mechanisms are the facility of built-in measures for reporting on resources used and results obtained.

Feedback on the organization level could be used to rate the performance of units as well as to determine areas for improvement by measuring performance against organizational goals. In turn, individual workers could know, rather than guess, how they have performed based on their own and higher management's objectives. For example, when report X was written, the work would be related to organizational needs and compared against other efforts. Such a mechanism, as described, would be extremely valuable toward determining the contribution of CBOS tools themselves. For feedback mechanisms to be useful and acceptable

to both management and the worker, performance data should be accurate, and correcting activities must be left to the originator's discretion.

System-environment Integration

As the number of users and applications increase within an organization, the demand for increased size and function will knock against the limitations of the initial application unless an architecture was initially used which planned for this growth. One means of planning for growth is to incorporate within the initial architecture the concept of integration with the environment.

> System-environment integration is the communication of information between the system and environment for the purposes of access, notification, transfer and monitoring.

CBOS access should be as easy as possible. This not only has implications for keystroke reduction but also for accessing the terminal, powering it up and so on. It should be configured so as to provide increased opportunities for access (i.e., more locations and activities) through a greater variety of means (i.e., text, voice, sensory, etc. terminals).

Signals and alarms to "devices" in the environment from the CBOS would allow greater use of the system in non-CBOS activities and thus impacting a greater percentage of organizational life. It would also enable the monitoring of simultaneous events. As a migration feature, activities would more easily "be allowed" to cross the system-environment boundary. Examples might include, "bells" to signal that particular messages require attention even though the user was not "logged-on" to the system, and automatic call forwarding of telephone calls when intended recipients had events on their calendars that indicated they were not to be disturbed.

For those events, machines, etc. which were not initially conceived as being included in the CBOS, access to the CBOS could be maintained by "gateways" with specific abilities to communicate. This is done using common network standards, least common denominator protocols, translations programs, black boxes, etc. necessary for the two "foreign" systems to communicate.

Monitoring of gateways as well as the increased access and signaling to the environment would bring about several benefits: system boundaries would less likely act as barriers requiring additional efforts by users, an understanding of the environment could be developed by the CBOS, and the eventual complete control of the business's resources might be achieved.

Summary

This paper outlined some current benefits and limitations of computer-based office systems to illustrate the opportunities for improvement in their design and implementation. By using a "social" perspective and engaging those who understand it in the highest level of specification for future CBOS architectures, the promises of increased productivity and quality of work life might be fulfilled. Examples of five requirements based on considering the corporation or organization as an important user perspective were given.

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