
Chapter 1
**The Outlook for Office
Automation Technology, 1985-2000**

Contents

	<i>Page</i>
Introduction	3
Organization of Report	4
Looking to the Future	5
What is Office Automation?	6
Understanding the Impacts of Office Automation	8
The Technology of Office Automation—Present and Future	11
Distributed Information-Handling and Networking	11
Proliferating Options 1	12
The Capture of Data.	13
Communication Between Organizations	13
How Rapidly Will Office Automation Occur?	14
The Possible Consequences of Office Automation, 1985-2000	15
Economic and Employment Effects	15
Training and Education	17
Organizations and Jobs	18
Office Workers and Their Workplace	19
Data Security and Confidentiality	20
Home-Based Office Work	21
Off-Shore Performance of Office Work....	21
Federal Government Office Automation	22
State and Local Government Offices	23
Small Business and Office Automation	23
Working Women and Minorities	23
Policy Issues for Congress	24
Further Discussion: Policy Issues and Questions	24
Employment.	24
Conversion to Part-Time, Temporary, and Contractor Status	26
Training \$	26
Labor/Management	26
Health and Safety	26
Data Security and Confidentiality	27
Home-Based Clerical Work	27
Off-Shore Office Work By or For U.S. Firms	28
Federal Procurement Policy	28
Federal Personnel Policy	28
State and Local Governments	28
Small Businesses.	28
Women and Minorities	29

Figures

<i>Figure No.</i>	<i>Page</i>
1-1. Changing Structure of the Work Force	3
1-2. History of Technology Used in the Office	9
1-3. User Institution Model of Technological Change	10

The Outlook for Office Automation Technology, 1985-2000

INTRODUCTION

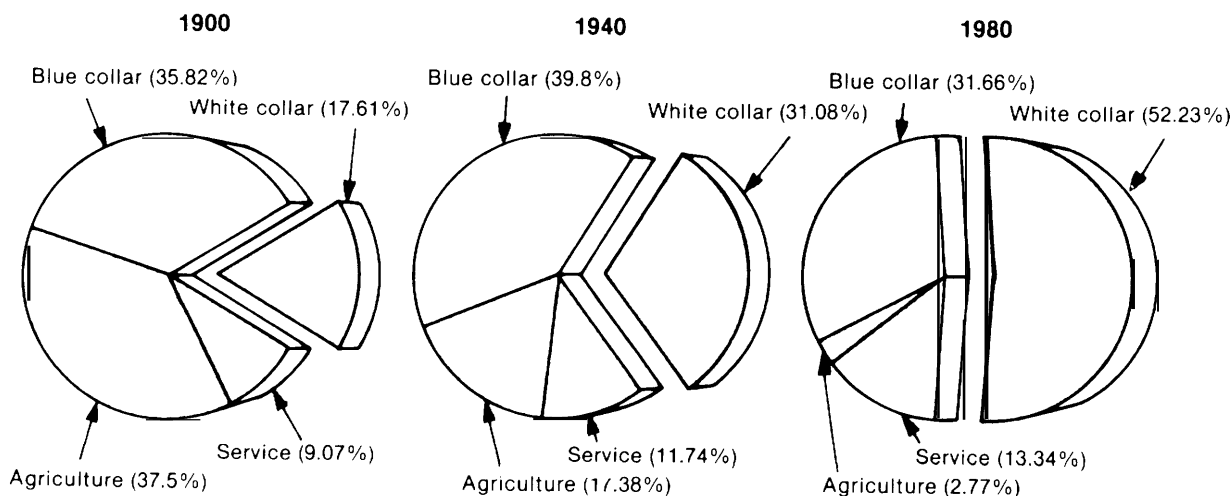
America has become an information society. Our economy is driven as surely by the incessant demand for information as it is by the continuing necessity of converting raw materials into finished products.

The majority of American workers are now white-collar workers, and about 45 percent of all American workers work in offices. (See figure 1-1.) Office work is rapidly being "automated," or computerized. What does this mean for the productivity of office workers and the number of office jobs that will be available in the future? What skills will white-collar workers need? What job ladders will be open to them? Will the quality of their working life be better, or not as good? What new opportunities and new problems can we expect, as a result of sweeping technological change in America's offices?

These were some of the questions that led the Senate Committee on Labor and Human Resources and the House Committee on Education and Labor to ask the Office of Technology Assessment (OTA) to conduct a study of the growing use of microelectronic information and communication technologies in office work.

With less than 3 percent of the labor force now employed in agriculture and the proportion of blue-collar workers steadily declining, the automation of white-collar work inevitably raises concerns about the number of jobs that will be available for the still growing labor force in the long-range future. This report deals with those white-collar workers who primarily work in offices, although information technology is also affecting others, for example, department store clerks and supermarket cashiers.

Figure 1-1.—Changing Structure of the Work Force



SOURCES: 1900, 1940: U.S. Department of Commerce, *Historical Statistics—Colonial Times to 1970*, Series D, 182-232; and 1980: U.S. Department of Commerce, *Statistical Abstracts of the United States: 1981*.

But American industry is now participating in a global economy. Competition for both world markets and domestic markets is a powerful incentive for seeking higher productivity. Microelectronic technology has enormous potential for increasing productivity in white-collar work, which is a large and growing part of every industry sector.

The office is the primary workplace for many industries, such as banking, insurance, and real estate, but the office is also a vital element of every industry from manufacturing to farming. An OTA assessment of factory automation, for example, found that ". . . the salaried or white-collar work force will constitute a larger proportion of manufacturing employment¹ in the future. Increased productivity in office work thus would contribute to productivity and growth in all sectors of the economy.

The demand for information will continue to grow. With computerization, the unit cost of collecting, processing, distributing, and using information will decline. More kinds of information will be gathered and used for new purposes, and many new information services and products will be created. Demand for information and increased productivity are two major factors in the employment equation; the consequences of office automation for office

¹U.S. Congress, Office of Technology Assessment, *Computerized Manufacturing Automation: Employment, Education, and the Workplace*, OTA-C IT-235 (Washington, DC: U.S. Government Printing Office, April 1984).

employment will depend in large part on the interactions between them.

Just as the successive waves of mechanization of farm and factory work have changed U.S. society and economy, so will the automation of white-collar work. Social and economic transitions in the past have raised policy issues that had to be addressed, and in many cases are still being addressed, by Congress. The new wave of automation will also create both opportunities and problems that demand the attention of Congress.

Technological change is also related to questions already on our political agenda, such as comparable worth and pay equity, international trade, and health and safety in the workplace. The effects will eventually be felt by everyone—producers and consumers; managers, professionals, and clerical workers; large and small organizations; the private sector and the public sector. The role that information and communications technologies will play in offices in the future, and the opportunities and problems they present, thus concern all Americans and all of their representatives in Congress.

This report puts before its readers a broad range of likely consequences of office automation, and calls attention to large areas of uncertainty. It points to some public policy issues that are emerging or may arise. Many other questions must and can be resolved only by the informed choices and cooperative efforts of individuals and organizations.

ORGANIZATION OF REPORT

After a brief look at the context of office automation from the perspective of history, this chapter highlights some expectations about the technologies and their development over the next 15 years. It introduces a con-

ceptual framework or model that guided the assessment. It then summarizes the findings of the assessment, identifying policy issues that are likely to concern Congress over the next decade.

Many of these issues are just coming to public attention and have not yet been widely discussed; specific proposals for dealing with them have not been put forward. A few of the issues, however, are already before Congress or are apt to be the subject of congressional consideration in the near future.

Chapters 2 through 6 discuss the possible effects of office automation in more detail. They deal with potential effects on employment levels; the kind of training and education needed for office work; changes in work content, jobs, occupations, and organizations; the quality of work life, the office environment and labor management relations; and the security and confidentiality of information.

Chapters 7 and 8 consider two alternatives to conventional offices, made feasible and economically attractive by office automation. The first of these is home-based work, especially the use of the worker's home as the primary or sole site for clerical work. The second is off-shore performance of data-entry operations, in which work is sent off to be done in countries with lower paid workers.

Chapters 9 and 10 look at office automation in the public sector—Federal agencies and State and local governments.

Chapter 11 is a brief survey of the limited information currently known about office automation and small businesses, an important sector of the economy that is just beginning to automate its offices.

Chapter 12 considers the implications of office automation for two groups that are likely to be particularly strongly affected: working women and minority white-collar workers.

Appendix A describes office automation technology as it is now and as it is likely to develop between 1985 and 2000.

Appendix B summarizes case studies of the automation of several offices to provide some examples of the changes that occur when offices are automated. In particular these examples illustrate the variety of offices affected and the difficult transition stage that occurs as offices automate their work.

The summary discussion in this first chapter is keyed at appropriate points to later chapters, where the reader will find more lengthy discussions.

LOOKING TO THE FUTURE

During the present transitional stage of office automation, there are many problems that are real but do not require congressional action. Some of the fears that people have in anticipating technological change later prove groundless. Many problems are resolved by ingenuity, trial and error, and negotiation between groups that have competing interests but a shared motivation to benefit from technology. Structural changes in the economy, on the other hand, can create lasting inequities and conflicts. They can also open up new opportunities to resolve old issues and realize new social benefits.

OTA chose a 15-year perspective because Congress will be concerned less with ephemeral

effects and transitional problems than with long-range structural changes. These structural changes are likely to become clearly visible only after office automation has been widely adopted and organizations learn to use its full capabilities.

Information and communication technology is itself rapidly evolving and expanding its capabilities. The range of technological choices that an organization has for accomplishing any given information-related objective is wide. The number of manufacturers and vendors of office automation equipment is large, and the competition between them is strong. This suggests that the technology of office automation will be strongly influenced over the next dec-



Photo credit Library of Congress



Photo credit. Michael J Smith

The evolution of the office environment is shown in these two photos from 1897 and 1980. Perhaps in the future there will be a truly paperless office.

ade or more, by the needs and wishes of the users.

The as-yet-undetermined characteristics of future office automation technology will strongly influence the social consequences of the automation of white-collar work. But changes in the U.S. economy and society are not, or need not be, entirely technologically determined. They depend in part on choices and decisions made by individuals and organizations, and they also can be guided by public policy.

The conclusions of this assessment are therefore conditioned by unavoidable uncertainties about the choices that users will make, about economic growth, and about future public policies. Major directions in the evolution of the technology can be discerned, but when these technical improvements will occur is more uncertain. It is most prudent to assume that some technical breakthroughs may come sooner than

now projected, rather than later, since this has happened repeatedly in the last few years.

Also uncertain is the speed with which offices will adopt new technologies. This will be influenced by general economic conditions, but in the last decade office automation has been less sensitive to these factors than many expected. Because it can be accomplished incrementally and with relatively small investments, adoption of office automation may be much wider, more general, and more rapid than has often been the case with new technologies. This makes transitional problems more visible and structural problems more important-e. g., displaced workers will have fewer options for adjustment if their occupations are affected in most regions and most industries in a relatively brief period. It also indicates that decisionmakers should now begin to attentively monitor the changes that are occurring, in order to be prepared to deal with problems that may arise.

WHAT IS OFFICE AUTOMATION?

Almost any place where information handling is the main activity is called an office, whether it is one person at a desk or a complex hierarchy of executives, professionals, and

clerical workers. For the purposes of this report, the office is wherever "office work" is done, and "office work" is the processing and use of information for the purpose of track-

ing, monitoring, recording, directing, and supporting complex human activities.' One of the striking consequences of information and communication technologies is that together they make much "office work" independent of the place where it has usually been performed; that is, they allow it to be done in the home, in airplanes and trains, and in other countries.

For the purposes of this report, the term "office automation" is used broadly to mean the application of microelectronic information technology and communication technology to office work. It includes large "mainframe" computers, smaller minicomputers, personal computers or microcomputers, stand-alone word processors, and the many diverse com-

²By extension, people also speak of places where other professional work is done as an office—e. g., a dentist's office. In this report we attempt no rigorous definition of what is or is not office work, but use a commonsense approach. We have generally excluded from consideration such peripheral or specialized places of white-collar work as the dentist's office, the scientific laboratory, and the draftsman's office.



munication devices and systems that can link them together.

The first offices may have been in the homes of Babylonian merchants or Phoenician traders, or perhaps they were construction project offices in the palaces of Egyptian Pharaohs. Almost certainly something like an office came into existence as soon as records could be kept of the exchange of goods, on clay tablets, chisled stones, papyrus, and quipus.³ Office work is inseparable from commerce because it is concerned with gathering, keeping, and using information about human activities, and particularly those activities that have to do with the production and exchange of goods and services.

If office work began in the homes of merchants and traders, it has nevertheless for most of history been done in central locations close to the production of goods and services.⁴ The office plays the same role for an organization that the brain plays in a living organism. It receives information flowing in from all parts of the organization (or organism) and from the external environment, processes that information and sends back responses, instructions, and commands through an extended nervous system—established channels of communication.

At the dawn of written history, clerks and scribes were the first office workers. Information handling work has always carried with it a degree of respect or status (even when many scribes were slaves) because it requires skills and education that, through most of history, few people had.

The tools used in this work were for thousands of years very simple, basically writing implements and something to write on, and some means of storing the records written or received. As the scale of human activities increased, the information about them became more voluminous and more diversified. The tools became slightly more sophisticated (a

³Quipus were knotted cords used by the Peruvian Indians (who did not develop writing) to keep records.

⁴One of the effects of new communication and information technology may be to allow office work to again be done in homes; see ch. 7, "Home-Based Automated Office Work."

bookkeeping ledger rather than a stone tablet or roll of papyrus) and office workers became more numerous and more specialized. When clocks were invented, the work became more subject to measurement, pacing, and management control. When electric communications were invented, it became less sensitive to proximity but more sensitive to time.⁵ But not until the advent of the telephone, the typewriter, and the adding machine, near the end of the 19th century, was a significant part of the work automated. (See figure 1-2.)

The mechanical stage of office automation was followed by the electromechanical stage, with electric typewriters and calculating machines. The present age of computers began a little more than 15 years ago, and this assessment looks forward for another 15 years—together, only about one generation in human terms, and less than the working lifetime of a white-collar worker.

Through the mechanical and electromechanical eras of office automation, white-collar work continued to be labor intensive. Capital investment in office work has always been low compared to capitalization in other economic sectors such as manufacturing and agriculture.

⁵Note that until the 1840s, and the invention of the telegraph, it might take days or weeks to communicate with another office in a different part of the country. Until the transatlantic cable of 1866, it took at least 4 weeks for a merchant to send a message to his field agent in Europe and get a response, and it might take months to exchange messages with the ship carrying his goods, since he could not know when and where it would make port.

UNDERSTANDING THE IMPACTS OF OFFICE AUTOMATION

In carrying out this assessment, OTA used a simple 'conceptual model as an aid in looking for the possible effects.'⁸ (See figure 1-3.) It suggests that when organizations adopt new technology, there are likely to be three kinds

⁸This model was developed by J.F.Coates and V.T.Coates; for an example of other assessments in which it has been used, see V.T.Coates, et al., *A Retrospective Technology Assessment: Submarine Telegraphy* (San Francisco: San Francisco Press, 1980); and V.T.Coates, "The Potential Impacts of Robotics," *The Futurist*, February 1982.

About 85 percent of office operating costs are labor costs.

Now capitalization is occurring rapidly, in the form of information and communication technologies that are transforming the nature of white-collar work.

Many other forces have affected office work in recent decades. The scale, geographical scope, and concentration of economic enterprise, and therefore of offices, has increased. Some sectors of industry and commerce have expanded and some have shrunk in importance. The growing pervasiveness of science and technology as components of the economy has both increased the demand for data and changed the nature of the information handled in offices. There has been a strong tendency to professionalize and credentialize many occupations.

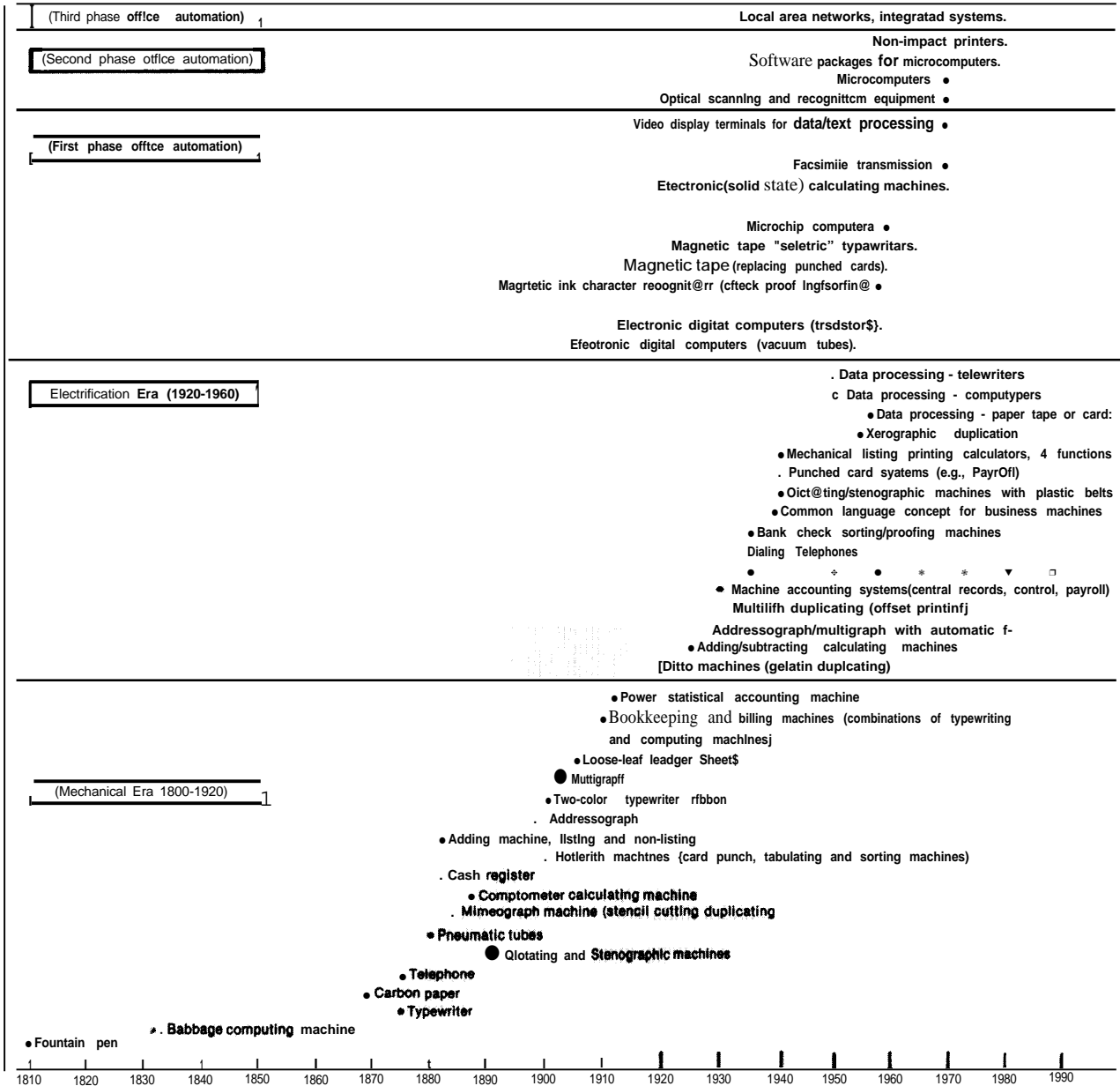
The office work force has also changed. The average educational attainment of office workers has increased, yet the educational gap between office workers and the general population has narrowed or disappeared. Women, once a very small part of the office work force, now make up the larger part of it. Changes in values, lifestyles—and some claim, the work ethic—have affected office workers along with all others in society.

These trends are all important. But technology or the tools people use, have a primary affect on their work, how it is done, and how it is rewarded by society.

of effects: substitution, adaptation, and transformation.

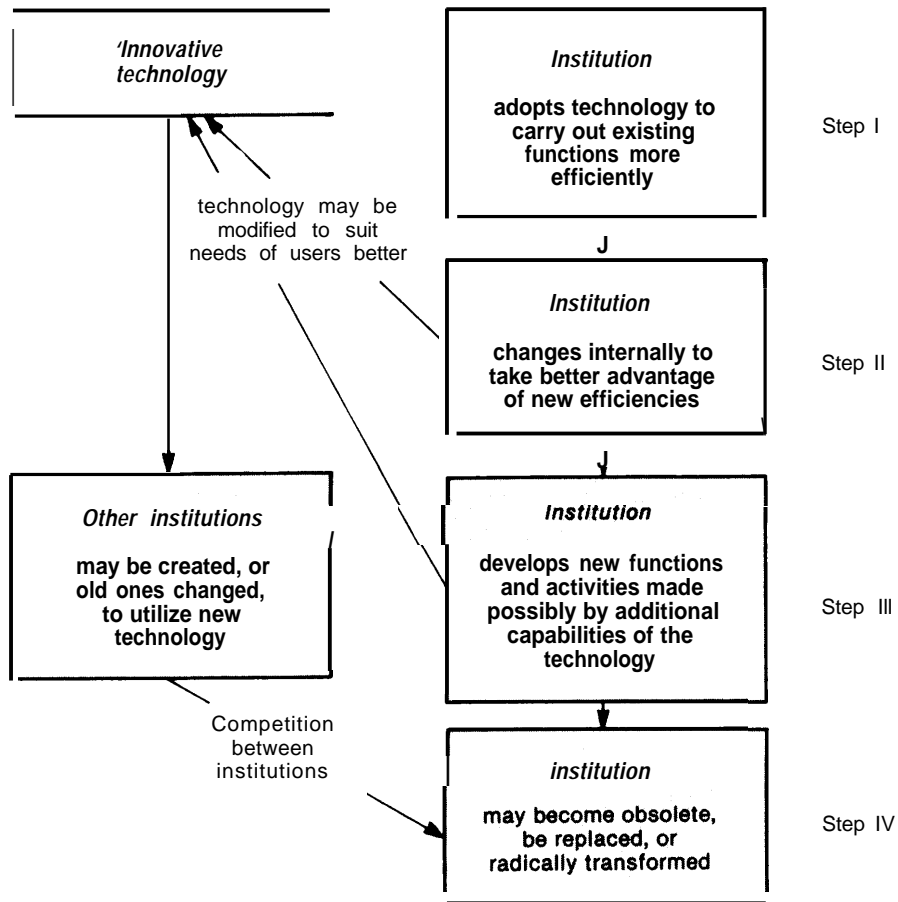
The new technology usually replaces an older technology or human labor, or both. There are direct substitution effects, both at the task level and at the organizational level. As word processors and computers replace the typewriter, bookkeeping ledgers, and payroll systems, and other communication systems augment telephones, there are effects on productivity, size

Figure 1-2.— History of Technology Used in the Office



SOURCE Office of Technology Assessment

Figure 1-3.— User Institution Model of Technological Change



SOURCE Joseph T Coates, "Aspects of Innovation" Public Policy Issues in Telecommunications Development, " *Telecommunications Policy*, vol. 1, No. 3, June 1977.

of work force, job content, the skill required of workers, etc. These effects are perceived as "good" or "bad" depending on one's perspective and interests.

The institutional structures, culture, operating procedures, and management expectations at this point still reflect the old workflow and work process. Tension is created because the characteristics of the new technology are different, and the requirements for effectively using it are different. Until this tension is resolved, the full benefits of the substitution are not realized and productivity may even fall. Many organizations are still at this stage in office automation.

The institution deliberately or "unconsciously," by plan or by trial and error, begins to modify itself to suit new ways of doing things. This is the adaptation stage. The adaptations may include for example formal reorganizations, shifts in power relationships, adjustments in responsibilities, or changes in the way workers are recruited and compensated.

Two kinds of problems may arise in this phase. If significant changes are made quickly and by explicit decisions, they may evoke resistance and resentment from those who lose power or who are uncomfortable with any change in the status quo, especially when people do not understand the reasoning behind

the changes or have not participated in the decisions. On the other hand, if adaptations are not planned, there may be a long period of frustration and inefficiency before common sense indicates just what changes are necessary.

The third kind of effects, transformations, come about because new technologies are likely to have entirely new capabilities not offered by the older technologies. The organization may develop new activities, products, or services, using these capabilities. For example, computers offer not only a more efficient way to do bookkeeping, but also the capability for continuous inventory control, not possible before. They make it possible to target mailings to special customers, and track the results. Some organizations began, as soon as they computerized their own data processing, to offer these services to others. This round of effects may bring about the restructuring of an industry or of the mix of industries within the

economy. The financial services industry,⁷ for example, used the new technologies to avoid legal boundaries between banks, insurance companies, brokers, and other elements of the industry.

Some organizations fail to adopt new technology, even when it becomes the norm among competitors. They risk eventual obsolescence and failure. For example, mail order businesses that have not automated customer services are in serious trouble. The feedback loop in the model is important; further development of the technology is shaped by the market and by the demands of users. New businesses may be spawned that specialize in innovative use of the technology, or specialize in helping other firms use it.

⁷See U.S. Congress, Office of Technology Assessment, *Effects of Information Technology on Financial Services Systems, OTA-CIT-202* (Washington, DC: U.S. Government Printing Office, September 1984).

THE TECHNOLOGY OF OFFICE AUTOMATION— PRESENT AND FUTURE

The dominant trends in office automation, from 1985 to 2000, are likely to be:

- a continuing strong movement toward microcomputers and toward distributed data access and data handling, usually superimposed on rather than superseding centralized automatic data processing;
- more powerful, easier to use, software;
- a strong trend toward linking and networking of microcomputers, minicomputers, mainframes, and peripheral and supporting systems;
- increasing choice among technological options for accomplishing information handling objectives;
- more and more capture of data at the point of origin, decreasing the need for repeated keyboarding and centralized data entry; and
- growing capability for communication, between devices, between organizations, and between locations.

Distributed Information-Handling and Networking

In about three decades, there have been three overlapping phases of computer-based office automation: centralized computing, decentralized or end-user computing, and networking.⁸ Before the last decade, large organizations were preoccupied with computerizing their mass data handling and typing, and were developing large systems and a corps of computer specialists to run them. This gave rise to the familiar “EDP” (electronic data processing) or “ADP” (automated data processing) center, staffed by computer specialists, primarily for batch processing of data and the development of large corporate databases.

⁸The reader who wants a more detailed description of office automation technology (but one still intended for the lay reader) and a discussion of the outlook for its development over the next 15 years, may go directly to app. A.

In industries that deliver customer services, such as insurance, this phase is sometimes called "back office automation," since it chiefly affected the part of the office characterized by large numbers of clerical workers doing the kind of paper processing seldom seen by the consumer. They entered data into the computer using "dumb terminals"—i.e., using keyboards that fed data to a large central computer that did the processing. Many organizations established central word processing departments or pools, in which specialized clerical workers took over the "typing" (or at least the keyboarding of all lengthy documents) for a department or for the entire organization.

The second phase of computerization began in most organizations about 1978 to 1980, with the introduction of small stand-alone word processors and microcomputers or personal computers (PCs), used by people who are not computer specialists. Software packages allow people who know little about computers or the arcane skills of programming to draw on databases or add to them, to manipulate text and quantitative data, to generate tables and graphic displays, and to exchange information with other computer users, without the direct mediation of computer specialists. PCs are increasingly used by managers and professionals as well as by support staff. Many executives who would not ever have typed now use word processing to draft letters, memos, or reports, or generate reports using spreadsheet software.

This has come to be known by the awkward term "end-user computing." Today, the use of computers by nonspecialists—end-user computing—is a highly visible trend. End-user computing is not replacing central computers, but is often added to or superimposed over a centralized EDP process within an organization.

The third phase is already beginning—the linking together of microcomputers, and the linking of microcomputers to mainframes or minicomputers so that they can act (compute) either independently or as an extension of the larger central processing unit. For the next decade, networking will be a major trend in office automation.

Such linked systems can also connect computers with printers and copiers, and with outside communications systems (telex, telephone lines, cables, etc.) to create "integrated office systems." Networking is not easily implemented. Because of the wide diversity in hardware, software, and interface mechanisms provided by vendors, it is often difficult to connect devices and systems so that they can "talk to each other" or work together as an effective system. In spite of these problems, in the last 2 years many organizations have developed "networks" or linked systems, and the trend is rapidly gaining momentum.

Differences between centralized EDP computing systems and end-user computing will gradually blur. The first and second phases of office automation, considered separately, often appear quite different, but it will become less important whether a worker is using a dumb terminal, or a PC that is networked to other computers, because they will be able to access the same databases and perform roughly the same functions.

Proliferating Options

Broad choices among vendors, devices, systems, software packages, connecting devices, communications technologies, and service providers now characterize office automation. This range of choice, and the rapid evolution of the technology, creates problems for organizations that want to plan their automation rationally over a long period. However, it also allows offices to automate their work a few tasks at a time, if they so choose.

Microelectronic office equipment is a highly competitive industry, and this has contributed to both declining prices and expanding capabilities. The computer industry has become a consumer industry. Large volume buyers (e.g., the Federal Government) have a less dominant influence over the direction of technological development than the cumulative choices made by the great number of middle and small size organizations. Even within large organizations, the purchase of microcomputers and word processors has often been relatively un-

controlled and the authority to choose between competitive brands has often been decentralized and dispersed. Thus, considerations such as the overworked phrase “user friendliness” have become important in the design of office automation.

A striking feature of the market so far has been that only a few older office technologies have been eliminated completely.⁶ Many have preserved their special niche, often by incorporating microelectronic components—e.g., the typewriter and microfiche. Technologies that were once separate are converging—typewriters become like word processors that in turn become almost indistinguishable from personal computers. Telephones incorporate small computers, and computers serve as communication devices. No one piece of equipment does everything but nearly all do more than one thing. As a result, users can put together devices and components to meet specific needs, and there are few obvious limits to what information-handling tasks and functions can be automated in the long run. Few critical technical barriers exist to future higher processing speeds, larger memories, much improved input and output technologies, and full communication between systems and devices without regard to distance.

The Capture of Data

A large proportion of the work in today's offices involves putting data into computers. Whether data is generated within an organization or drawn from outside the organization, it usually must be keyboarded into computers for further processing. This is especially true for data that is collected on a disaggregated basis—orders placed or received, ticket stubs, invoices, checks, transport forms, vouchers, customer complaints, etc. When organizations exchange information either directly or through a client (e.g., payments and receipts, or a patient sending hospital bills to a health insurance provider) the information often must be

⁶Reprography has just about eliminated the multilith, mimeograph machine, and carbon paper—but not entirely. As yet, electric typewriters have not completely eliminated mechanical typewriters.

rekey boarded even if it came from one computer and goes into another computer.

But much of this work is being eliminated, or is likely to be eliminated in the future. Increasingly, computers are able to communicate directly with each other, through modems or other technological means. A second way of eliminating data-entry work is to allow (or require) a consumer or client to enter information directly into the organization's computer. This happens, for example, when a bank's customer uses an automated teller machine (ATM) to deposit or withdraw funds or shift funds between accounts, or when he/she uses a home computer to instruct the bank to pay his/her monthly utility bill. A third way of eliminating data-entry work is to have the computer directly read typed or printed information with optical scanning technology; or to enable the computer to “hear” and store information conveyed by voice (i.e., speech recognition). Optical scanning devices are improving rapidly and increasingly in use; speech recognition technology is in an earlier stage of development, but is already being used in a limited way.

A critical determinant of the results of office automation over the next 15 years is the outlook for computer input technology. Data entry, including word processing, is probably the largest single computer-related category of clerical employment today. Organizations are seeking and finding ways to avoid the necessity of keyboarding data for a second, third, or fourth time. Beyond that is the possibility of never having to keyboard it. If this happens, then both the number of jobs dedicated to data entry, and the costs of data handling will decline dramatically—at least, for a given volume of data.

Communication Between Organizations

As already noted, one way to avoid secondary entry of data is for interacting organizations to exchange data directly from computer to computer. For example, a hospital computer may send bills directly to the health insurer's computer, which instructs the bank's computer to transfer funds; the bank's computer



Photo credit: Bell Labs

One characteristic of office automation is the integration of computing and communication technologies

then notifies the hospital's and the insurer's computer that the payment has been accomplished. As another example, the computer of a manufacturer may receive an order from the computer of a customer, then order and coordinate the shipment, with the payment handled and recorded by direct communication between the computers of the buyer, seller, and bank. A few pairs of organizations are said to have such linkages operating at present; more are likely to do so in the future.

How Rapidly Will Office Automation Occur?

Office automation may proceed more rapidly and penetrate economic activities more thoroughly than have other waves of automation. The pace of technological change has, in the past, repeatedly confounded expectations; sometimes it has been slower than expected, sometimes more rapid. Much depends on the resources required to adopt new technology, the time required to recover the necessary investment, and the economic conditions that prevail. Particular factors of importance are the costs of capital and labor; the availability of people to use and manage the new technol-

ogy; the structure of the adopting industry or industries, and their competitive environment; and a variety of social and behavioral factors that can be collectively called organizational culture.¹⁰

An examination of these factors in relation to office automation points to a relatively broad and speedy adoption. The role of offices and office work is tending to increase in every sector (i.e., there is more "paper work" or information-handling in the production of all goods and services), and automation can be adopted by and adapted for offices in every industry sector. Many kinds of office activities are similar in all organizations-generating text, keeping records, circulating memos, preparing payrolls, filing, etc. Because many kinds of office automation can be implemented incrementally, and at relatively low cost, it can be adopted by small as well as large offices.

There are a variety of reasons for automating information-handling, from reduction of labor costs, to improving the quality or variety of services, to reaching a larger market in a given time. If an organization adopts automation for the purpose of providing new services or products, or reaching a new market, its competitors may feel forced to do likewise.

The effects of technological change often depend on how rapidly that change occurs. Problems may solve themselves if there is much time to adjust. On the other hand, opportunities not quickly grasped may be forever lost, or problems left to drag on may fester. Later chapters of this report will point to organizational and behavioral problems that could slow the adoption of office automation. At present however, it appears that these are largely transition problems for which many solutions are being developed.

¹⁰The analysis here and in ch. 2 draws on an OTA contractor report, J.D. Roessner, "Market Penetration of Office Automation Equipment, Trends and Forecasts," November 1984. This report is part of an OTA contractor report, A.L. Porter, et al., "Office Automation Outlook: 1985 -2000," February 1985.

THE POSSIBLE CONSEQUENCES OF OFFICE AUTOMATION, 1985-2000

Some emerging and potential policy issues identified by OTA are of interest because contending parties have already voiced their concerns, and in some cases, related proposals are before Congress. Most of the policy issues, however, are of more long-range concern or are contingent on conditions anticipated but still in the future.

In relation to most of the policy issues, some attempt has been made to indicate potential congressional responses. This is done to indicate the range of conceivable policy interventions. OTA has not fully evaluated all of these policy options in terms of their own possible effects, or the pros and cons of adopting them, either in this chapter or in the course of the assessment.

Economic and Employment Effects

Increased Productivity

By the mid-1990s nearly every office will have at least one computer, just as nearly all offices now have telephones. There will probably be a terminal of some kind for at least every two or three office workers. Since many organizations will by then have adapted their work process and work environment to the new technology—although restructuring and change will surely continue—many solutions to current transitional problems should be available. Office productivity should increase significantly.

Productivity in white-collar work is difficult to define and measure, as is discussed in chapter 2. But however productivity is perceived by a specific office or industry, significant increases as a result of office automation will affect employment levels, at least for some office occupations.

Employment

There will certainly be a significant reduction in the hours of labor associated with a given volume of information-handling. The

magnitude of the reduction will depend in part on the technological trends noted above and in part on management strategies.

The reduction in labor will be most significant in the clerical/support occupations, especially those that predominantly involve data entry. Fewer lower level workers would in itself indicate a need for fewer first line supervisors and managers. But the span of management control can also be broadened by automation of the work process. Thus, fewer managers may be needed (again, for a given volume of information-handling). Some of the tasks of lower level managers can be automated, or be taken over by clerical workers who are lower paid, so this tier of jobs is again likely to shrink. Some of the tasks of paraprofessional or technical workers may follow the same route. Professional occupations are less vulnerable, but not immune to the substitution and adaptation effects of automation.

Whether or not organizations have as their primary motivation for adopting office automation a reduction (or constraint on growth) in the work force, relatively few can yet demonstrate that they have achieved that result. Many have hired more workers. OTA case studies, internal corporate studies, interviews with business executives, and reports in trade literature have repeatedly shown such short-term inefficiencies resulting when a new technology is introduced into a workplace, process, working group, and organizational structure not yet designed to use it to best advantage. Yet most evidence suggests that in a given task, time and labor saving from automation is significant. Some tasks or steps are eliminated entirely.

Declining costs and the proliferation of new uses and needs for information argue for a strong and continuing growth in the volume of information-handling and thus for a steady increase in the office workload. The growth in demand for information and the reduction in labor associated with information-handling

are two competing trends—both associated with information and communication technologies—that will affect the level of future office employment. Which force outweighs the other is surely a judgment call; it may ultimately depend on broad economic conditions, other unforeseen technological developments, and choices and decisions made in industry, government, and society at large.

Because in the past, employment growth as a whole has continued through periods of technological change, many economists believe that the number of office jobs will continue to grow strongly in spite of office automation. Others doubt this because of the high potential efficiency of microelectronic technology in office work (especially clerical work), which has always been very labor intensive, especially since the economy is generally not expected to grow as rapidly in the future as it has in some past decades. For example, a recent scholarly article suggests reasons for the “common misconception” that future economic growth spurred by high technology will necessarily provide a net increase in jobs; the authors said, especially speaking of computers that:

... the impact of (new) technologies is likely to be more widespread than that of past technologies because their cost has declined so sharply relative to their capability and relative to the costs of labor . . . (and) the economic context has changed considerably from the past.”

The present capability for economic and employment forecasting is not good enough to resolve this very large uncertainty.

Thus, it is possible that there will be continuing strong demand for additional office workers. The most likely outcome, however, is slowing growth in the number of office jobs and even eventually an absolute reduction in the number of jobs in offices. While the latter outcome is by no means certain, there is sufficient evidence pointing in this direction to justify

—“Russell W. Rumberger and Henry M. Levin, “Forecasting the Impact of New Technologies on the Future Job Market,” *Technology Forecasting and Social Change* 27, 1985, pp. 399-419.

watchful concern by Congress, and to merit efforts to improve the monitoring of employment trends so that corrective or compensating actions can be taken when and if they are needed. Recent employment forecasts should not lull policymakers into complacency. This is an area fraught with uncertainty.

If the number of office jobs continues to grow, no congressional action will be called for; if that growth falters or reverses, there will immediately be strong demands for Federal intervention. However, early signs of trouble may be missed. At present, the Federal Government is poorly equipped to detect or understand early signals of problems arising from structural changes in the economy related to technology.

Labor force and employment data collection does not support analysis of emerging trends because it is necessarily collected, aggregated or disaggregated, and analyzed in categories that reflect the occupations and jobs framed around old technologies or occupational/disciplinary tools. Census data is necessarily old (in terms of today's rapid change) by the time it is available for analysis. Econometric models are insensitive to realistic expectations about new technology and the changing substitutability of capital for labor. There is a great need for improved databases, for greater attention to advancing the state of the art in both technological and employment forecasting, and for building and institutionalizing a capability that combines and integrates those two disciplines. No agency now has a strong capability of this kind, nor the resources and specific mandate to develop such a capability; moreover, there is very little Federal funding available for research into crucial areas of economics, social science, and organizational behavior related to this area. '2

The critical question for Congress at present is not one of immediate interventions, but how to improve the capability of the Federal Government to understand, and thus be prepared

—“Hearings of the Science Policy Task Force of the House Committee on Science and Technology, Sept. 17-19, 1985.

to respond to, technological and structural changes that are occurring in the United States and other advanced industrial nations.

Conversion of Employee Status

Office automation may enable employers to convert more employees into part-time and temporary workers or independent contractors. This allows offices to adjust their labor costs to a fluctuating workload, to reduce some overhead costs, and to eliminate or externalize some secondary labor costs (benefits packages). While some workers prefer and seek opportunities for part-time employment, the number of involuntary part-time or temporary workers has been slowly and steadily increasing. Significant growth in the use of part-time and temporary work forces could ultimately reduce the number of full-time jobs for those who need or desire them. It may also shift responsibility for benefits and protective mechanisms such as health insurance, unemployment and disability insurance, and retirement income to the worker, costs that may ultimately have to be assumed in part by the taxpayer.

Job Opportunities

In some occupations and industries, those tasks that have historically been at the cross-over point between clerical jobs and lower level management or professional jobs have been automated. In other occupations or industries, office automation has been used to narrow and specialize clerical tasks or to deprofessionalize tasks. In this way, some important channels of career mobility (job ladders) have been truncated. These effects are of special importance to women and minorities. In some industries or organizations those channels have only been opened to women and minorities within the last decade, and are looked to as a primary opportunity for escaping from poorly paid occupations and segregated "women's work."

Office automation also creates some new categories of jobs, or new specialties within existing occupations. Proficiency in solving problems related to office automation has given

many people the opportunity to create special roles for themselves and has led to new job ladders and career paths. Men and women with the capability, imagination, daring, and opportunity to rise to this challenge are moving into the upper levels of organizational hierarchies. Whether or not this career path will create anew pool of potential senior managers or chief executive officers, only time will tell.

Some of the likely effects on employment are not inevitable results of office automation, but result from management/institutional choices about the combination of technologies adopted, the way they are implemented, and the way the work is restructured. But to the extent that the technology may encourage business decisions to be made only on the basis of narrowly framed, near-term cost considerations, this could have a negative effect on both long-term productivity and future opportunities for productive and rewarding employment for many Americans.

Training and Education

A major factor in achieving the full productivity benefits of office automation is the availability of workers skilled in its use. From the standpoint of organizations and their managers, an adequate supply of trained workers to meet future needs is critical. From the standpoint of office workers, access to training and the ability to master new skills is critical.

In the short term, the training need not be lengthy or excessively expensive. The trend in both hardware and software is toward greater simplicity for the user, and more opportunity for self-teaching based on training procedures built into the technology. However, because office automation often brings about a drastic redesign and resequencing of tasks, both initial and continuing training is essential.

Training provided by vendors and by some employers is highly system- and task-specific. For the user, this makes training easier, but limits its future usefulness. Economic pressures, however, motivate some employers to provide no more than minimum training. Many

organizations, in deciding to automate, have underestimated the continuing training and support that is necessary, and these costs can dwarf the original investment. Some employers also see it as in their interest to make training as narrow, specific, and brief as possible. In that way they have minimum investment in workers who could then be lured away, and replacement workers can be trained rapidly. But this practice can also trap workers in dead-end jobs and limit their ability to move up to jobs of wider scope and higher skill requirements.

Many organizations are providing their workers with ample training both in their own interests and from a sense of responsibility to their workers and to the larger society. This is a significant cost to the employer. While in the long run it may increase the productivity benefits that the organization seeks, it may also defer the realization of sought for cost reductions.

Workers just entering the labor force also need training, at least in specific tasks or with specific systems. Those aspiring to management positions increasingly seek advanced training in business and business technology before entering the labor market. In recent decades, there has been a strong trend toward externalizing training costs and lateral recruitment—i.e., depending on colleges and commercial schools to train workers, and hiring from the outside at the management level rather than advancing people from lower levels within an organization. Enrollment in business schools, vocational schools, and adult education courses has been rising. The students, rather than an employer, bear the cost of this training; but since it is often out of reach for lower income families, this raises questions about equitable access.

Public schools and community colleges are to some degree handicapped by the costs of providing instructors and a wide range of equipment for students to learn on, especially since the technology is constantly changing and instructors themselves must be continually learning. Commercial schools may be in

some ways better able to respond quickly to market changes—i. e., to be able to invest in up-to-date technology and retraining for instructors. Again, the costs to workers of commercial courses, in terms of both money and time, mean that the most disadvantaged populations are put at a further disadvantage.

Organizations and Jobs

There is much controversy at present around the question of whether office automation enhances or “de-skills” office work. De-skilling means the standardization and routinization of tasks, in such away that human knowledge, judgment, and decisions are minimized and the technology (in this case a computer) directs, controls, and paces what a worker does.

Office automation can be used to de-skill tasks. It is, and has been, so used in many organizations that process huge volumes of standardized data. More data can be processed in a given time, by less highly trained (and lower paid, more easily replaced) workers, with less variability in outcome and—supposedly but not always in practice—with lower error rates. Professional tasks can also be de-skilled, by building sorting rules, decision trees, and analytical processes into computer processes and software packages.

For the worker, this may mean less job interest and satisfaction and increased stress. Factory-like offices could repeat the worst mistakes and problems created by manufacturing assembly lines. However, rationalizing work (i.e., simplifying and routinizing it) can also create new white-collar jobs for people with less ability and training than is required for some other office work. These jobs are highly valued by people whose employment opportunities are limited, or who are just entering the job market.

Office automation can also be used to enhance jobs, by relieving people of routine repetitive steps. Jobs can be designed to integrate simple tasks into fewer broader tasks so that the worker has a better sense of the purpose and outcome of the work. Informa-

tion systems can also give a worker access to knowledge that could previously be obtained only through advanced professional education, and thus allow a nonprofessional worker to take over interesting tasks previously considered the privileged province of the professional. For example, clerks can use computerized databases to search for information that formerly only a lawyer, medical doctor, biologist, or Ph.D. in history or anthropology would have known about. Some organizations are deliberately using office automation to upgrade and enhance work at all levels. As a result, they can sometimes develop a flatter institutional structure and reduce the costs of management.

Other kinds of organizational restructuring are likely to occur. There is evidence that adoption of large computers tended to lead to centralization of control. Adoption of end-user computers could lead toward some decentralization of decisionmaking. These shifts in power depend less on the characteristics of the technology than on the characteristics of the organization and its management strategy.

Almost always some redesign and restructuring of the flow of work is necessary, leading to shifts in responsibilities, jurisdictions, allocation of resources, and relationships between coworkers and between working groups. Communication patterns within the organizational hierarchy are likely to change. Typically problems arise over "ownership of information" and responsibility for assuring the integrity of organizational data banks.

There is more flexibility in implementing office automation than in most changes in basic technology; thus management has an even greater responsibility for the outcome. The ways in which organizations are implementing office automation and redesigning their work processes are rich in innovation and diversity. Results in terms of productivity will be a matter of debate for some time to come. Some organizations will be disappointed in their expectations, and this may make others more cautious about moving into office automation. But a great deal of cross-learning and shared learning is occurring, and many orga-

nizations may learn from the experience of industry leaders and thus shorten their own troublesome transition period.

Both in terms of productivity (because of the importance of motivation and job satisfaction) and in terms of equity and quality of work life, problems of work de-skilling, occupational downgrading, and disappearing job ladders could result in serious social problems. The handling of such problems is, in our system, usually a management prerogative or a matter for labor-management negotiations. Experience shows that the most fruitful strategy, both in terms of productivity and job satisfaction, is usually some form of worker participation or representation in the search for solutions. Less than 20 percent of office workers in the United States are represented by unions (although the growth of white-collar unions is said to be a high priority for labor organizations at this time). Organizations are now using or experimenting with other mechanisms for worker participation in decisions related to technological change and job design.

Office Workers and Their Workplace

With more and more Americans working in offices, there is growing attention to the quality of work life in offices, to job satisfaction, and to the effects of office work on physical and mental well-being. Office automation has aroused some added concerns in terms of the long-range effects of physical and mental stress, and fears related to work with computer video display terminals (VDTs).

Workers using VDTs have increased complaints about eyestrain and musculoskeletal problems. Better workstation design, improved human/computer interfaces, and work breaks from long periods of VDT work can greatly alleviate these problems. There is no evidence as yet that such problems, while serious in terms of day-to-day discomfort, lead to any organic deterioration or chronic disease or illness. However, evidence from other occupations with heavy workload and repetitive tasks suggests musculoskeletal strain in VDT work may lead to chronic health effects.

There has been serious concern over reports of clusters of reproductive failures and accidents among clerical VDT workers. Epidemiological investigation has so far not explained these scattered clusters; but scientific research has failed to find any possible cause related to VDT technology.

OTA has reviewed current information and ongoing research in this area and concludes that there is at this time no good basis for fear of VDT effects on reproductive processes. Scientific research should continue to be monitored for new findings.

However, office automation can increase stress on users. Stress is not always bad; it can be viewed as increased challenge. But some forms of continuing, unrelieved stress are clearly harmful. Concern in the past has emphasized the so-called "executive heart attack," but there is growing evidence that clerical workers are most likely to suffer from continued stress. Computer pacing and computer monitoring, which result in reduced autonomy or control over one's work and performance level, or which induce continuing visual and musculoskeletal strain, significantly add to stress. Fear and anxiety over one's ability to learn and perform effectively or to change one's management and supervisory strategies, as well as perceived job insecurity, create stress. There is increasing evidence that long-term high levels of stress are conducive to several kinds of chronic illnesses.

Visual and musculoskeletal problems currently can be alleviated through appropriate office and workstation design; stress-related illness or disease is more difficult to control and may emerge as the greatest public health problem among office workers in the future.

Involvement of workers in decisionmaking about office automation and work redesign appears to reduce stress levels. Organizations that have successfully sought the participation of users at all levels of the organizational hierarchy have reported that this led to higher productivity.

In some countries, there is already legislation or regulation related to office automation and quality of work life; for example, West Germany and France have regulations requiring regular eye examinations for VDT workers, and in Sweden there are standards calling for periodic work breaks.

Data Security and Confidentiality

Data security and the confidentiality of data in computers and data banks is a continuing concern. End-use computing adds to these concerns primarily because there is wider access to data and to means for manipulating it; data disks are easily lost, stolen, destroyed, or copied; computers are linked to other computers providing greater access; and small computers are not usually monitored or physically guarded. Control of databases is often separated from responsibility for their integrity and reliability. Most end-users are not as well informed about the requirements of confidentiality for client and employee data as are computer professionals. In addition, office automation often allows work to be done away from the office, in airplanes, at home, or in client offices, which further increases vulnerability.

Data can also be destroyed or made temporarily inaccessible by accidents, electrical outages, or natural disasters. As more and more data exists only in electronic form, and as day-to-day operations become more dependent on technology, there is greater need for secure back up.

Federal agencies, like private sector organizations, are faced with new problems in protection of data security and confidentiality as a result of decentralized office automation. But government offices have, in many cases, been more sensitive to this problem than has industry in general. Personal data about Federal employees or agency clients, however, may be inadequately protected.

There are both technological and procedural means for protecting data. Most organizations

have established these with regard to centralized EDP operations, but often overlook the vulnerability of data processed by end-user devices. Organizations moving into office automation for the first time may not realize the threats until serious problems arise.

Home-Based Office Work

A special and important capability of office automation technology, resulting from the convergence or combination of information and communications technology, is to allow work to be done at a distance from the office. The worker's home can become the primary work site. Home-based clerical work, with the work performed on a piece-rate or hourly basis, could increase significantly in the next few years. Already controversial, it would then become much more so.

The opportunity to work at home is highly valued by many workers. Many professionals now do part of their work at home, by their own preference and at their own and their employer's convenience. This flexibility is mutually beneficial and should be protected. A second kind of home-based, computer-mediated work is the performance of office services (e.g., word processing, data entry, analytical studies, computer programming, or consulting) by entrepreneurs who establish small businesses in their own homes. They sometimes find barriers to operating their businesses in the form of zoning laws or confusing tax provisions, but such ventures are proliferating in spite of this. Many women, in particular, are gaining business skills and experience in this way.

A more controversial form of home-based office work is the farming out of clerical office work (e.g., data entry and word processing) to be done in homes, usually by women and especially by mothers of small children. Home-based workers are often paid at piece-rates or hourly rates. They may be former employees converted to the status of independent contractor, thus giving up employee benefits. Critics object to this form of home-based work on the grounds that it eliminates jobs for regular employees and constitutes unfair competi-

tion, tending to depress the general level of clerical wages and preserve the segregation of women into the lowest level office jobs. They also argue that it is difficult to assure the workers of safe and healthy working conditions; and that it weakens social pressure for the establishment of child day care centers, accommodations for handicapped workers in the office, and other social services needed by workers employed under more conventional conditions.

A work-at-home opportunity at present is almost always sought by the worker, not forced by the employer. The most common reason is the need or the wish to combine paid employment with care of children or other household responsibilities. Some home-based work programs are designed for physically handicapped or retired workers.

At present only a few thousand people are engaged in homebased clerical work. However, the technological and economic conditions exist for substantial expansion in the future. If home-based workers begin to compete with office-based workers for a shrinking number of clerical jobs, then this issue will be much more highly visible and controversial.

Bills have been introduced before Congress that would encourage home-based computer work by means of tax credits. The AFL-CIO has called for a ban on home-based clerical work. Other groups argue for enforcement of existing occupational safety and health laws and other worker protection laws in home-based work.

There are legal questions to be resolved regarding the status of some of those designated as independent contractors; IRS has recently ruled that those accepting work only from one employer/organization must be regarded for at least some purposes as employees, not contractors.

Off-shore Performance of Office Work

Some U.S. firms have relocated their data-entry operations to other countries to take advantage of low labor costs. Intermediary en-

trepreneurs also make off-shore data-entry services available to U.S. firms. Recent advances in communications technology are making this activity increasingly cost effective, and it is also being encouraged by the Federal Government as a mechanism for assisting economic development in Caribbean countries. However, if predicted technology developments reduce the need for large-scale data entry, off-shore sourcing of data entry will probably cease to expand.

Off-shore clerical work for U.S. firms now involves only a few thousand workers, chiefly in the Caribbean countries but with some in the Far East and India. With further improvement in communications services, this activity could expand considerably in politically stable developing countries in many regions of the world. The governments of many developing countries, and U.S. economic development experts, perceive valuable potential benefits in encouraging this activity. It does, however, represent a direct loss of U.S. data-entry jobs.

Federal Government Office Automation

Effects of office automation will be felt in public sector as well as private sector offices. In Federal Government offices these effects have implications for procurement policy, personnel policies, and budgetary planning. They may have implications also for the delivery of government services, the access of citizens to government information, and the ability of citizens to participate in public decisionmaking. This report only briefly considers such effects on the quality of governance, primarily in terms of the possibility that loss of accountability could result from erosion of established bureaucratic communication channels.

Present procurement and acquisition policies have, in general, allowed the Federal Government to keep pace with the private sector and to adapt office automation technology to the needs of Federal agencies. There are some conspicuous exceptions and some unsolved problems. Chief among these problems are the lack of compatibility among devices, which is ham-

pering networking within agencies and between agencies and field offices; and the lengthy procurement cycle for large systems, which is out of step with the rapid evolution of the technology.

Gains in Federal office productivity are obvious, yet hard to measure or document. Some agencies have been able to handle greatly increased workloads without a proportionate increase in the work force. There are, however, built-in disincentives to achieving maximum cost reductions. Government managers are offered few rewards, and may suffer subtle penalties for reducing the number of people they supervise or cutting their annual expenditures. Grade level or promotion may depend on the number of people one supervises, and unexpended funds may encourage further stringent budget cuts.

There has been strong pressure by the Administration to reduce Federal employment. There are some indications that office automation may have already contributed to curbing the growth of the Federal work force. A significant reduction in the number of clerical workers and a change in the ratio of clerical to professional and administrative employees seem to have occurred, along with changes in job content and skill requirements that are likely to continue to accelerate.

The Federal Government has a responsibility to see that changes in Federal white-collar employment, working conditions, and career opportunities are managed smoothly, equitably, and with due concern for civil service employees. There should be continuing reexamination of job classifications and classification criteria. Uncertainties in future employment levels should affect present recruitment and hiring, and projected changes in future employment needs should also guide the planning for retraining and redeployment of present employees. Such changes are not being systematically tracked, studied, or considered in personnel or budgetary planning.

Since 1975 there has been a slight rise in average grade levels, which was strongly criticized by the Grace Commission as overgrad-

ing. The changes in occupational distribution (i.e., a smaller proportion of clerical workers) may have contributed significantly to this slight rise. Neither the Office of Personnel Management nor Congressional Budget Office has accounted for this factor in their analysis of the grade level rise. If the number of lower level workers has been reduced, and will be further reduced, then efforts to hold constant the average grade level will significantly hinder the ability of the Government to attract and hold highly qualified middle and upper level employees.

State and Local Government Offices

State and local governments are struggling to manage an increased workload, partly resulting from present Federal policies, without a proportionate increase in staff. The more than 78,000 governmental units in this country show a rich diversity in approaches to office automation, both in large systems for many governmental operations and more recently in end-user computing. Small cities and rural counties are lagging in use of office automation, in spite of the opportunities presented by microcomputers. In part, this probably results from lack of access to expertise to help them in choosing and supporting office equipment and training workers.

There is, at this early stage, little information about the aggregate effect of automation on local and State government offices across the country. Evaluations of productivity so far show mixed results. Some researchers, in specific States and localities, have found evidence of increased productivity and of work force reduction, others have not. Some researchers have reported findings of standardization and depersonalization of government services, of strong reinforcement of the existing distribution of bureaucratic and political power, and of increased difference in the relative access of citizens to government information.

Small Business and Office Automation

The effects of office automation on small businesses are of particular concern to Con-

gress because of the vital role that these organizations play in job creation and in innovation. Small computers and improved software packages appear to make office automation more practical for small organizations, but can still represent a significant capital investment in comparison to their assets. The time required to make informed decisions about equipment, to redesign work procedures, and to train staff, plus the lack of in-house expertise in trouble shooting and problem solving are also significant problems.

Although computer vendors identify small business as an active and growing market, there is little empirical evidence about the results of their experience with office automation so far. Optimists hope that automation may allow small firms to expand their markets and successfully compete with larger organizations. Pessimists fear that many will incur capital costs beyond their ability to support. Their experience should be carefully monitored for emerging public policy concerns.

Working Women and Minorities

The effects of office automation are of particular concern to women. Most clerical jobs are now held by women, and one-third of working women are in clerical occupations; they are vulnerable to displacement. Women now in clerical positions are trying to move into managerial and professional jobs, but some job ladders may be truncated by automation. In managerial and professional occupations that are vulnerable to office automation, women tend to have less seniority than men. On the other hand, some new jobs and occupations, offering good potential for advancement, are being created by office automation; access to education and training for these specialties is vital for women.

As skill requirements and training prerequisites for traditional office jobs change, their comparability to other jobs changes, but these shifts may not be reflected in changes in job titles or even in formal job descriptions. Debate over pay equity and comparable worth requires understanding of the changing nature of office work and its changing skill requirements.

Office automation is also of particular interest to minorities, and for similar reasons. Clerical jobs have often been the first step in white-collar work for disadvantaged groups.

Minorities, especially Black and Hispanic women, are disproportionately represented in jobs likely to be directly affected by office automation.

POLICY ISSUES FOR CONGRESS

A number of policy issues have been identified above, and are discussed in more detail in the following chapters. OTA has concluded that:

- Many of the concerns that have been raised with regard to office automation are transition problems that will be solved by market forces and by the common sense and ingenuity of users—they do not require Federal action of any kind.
- Some concerns—most importantly, the possible effects on future white-collar employment levels—are matters of long-term national interests. They merit watchful attention, and Congress should begin now to make sure that the nation is prepared to deal with them if and when conditions warrant action. This however will be difficult to do, because the capability to detect and understand emerging structural change in the economy is poor. Better economic and employment data and development of improved forecasting techniques are urgently needed.
- There are a few specific issues of immediate concern; some of them are already the subject of legislative proposals before Congress or State legislatures. These include, for example:
 - documented or suspected health problems associated with office automation,
 - proposals to encourage or to ban home-based office work, and
 - largely unexamined relationships between pay equity and comparable worth questions and the changes associated with office automation.
- There are also specific issues of concern to Congress in its oversight of Federal agencies and activities, including:
 - the implications of Federal office automation for procurement, personnel, and budgetary policies, and
 - adequacy of present provisions to assure data security and confidentiality and continuation of Federal functions under emergency conditions.
- An emerging issue, which may become more important and more controversial in the near future is the beginning trend toward off-shore sourcing of data-entry work.
- There are several groups for whom the effects of office automatic are particularly important and whose interests merit special attention:
 - women in clerical, managerial, and professional office positions,
 - minority workers, and
 - small business firms.

FURTHER DISCUSSION: POLICY ISSUES AND QUESTIONS

Employment

In the immediate future, the anticipated effects on employment are only possible or probable. There is little evidence that decline in growth in, or reduction of, the number of of-

fice jobs is already affecting large numbers of people. It is therefore attractive to think of immediate actions that would position Congress to act in timely fashion when and if the need becomes real. A prudent preparatory

strategy would be systematic monitoring and research to clarify the emerging effects of office automation and provide an alarm signal if they seem likely to exceed acceptable limits. This would require actions to improve the collection and collating of occupational and employment data, and improved mechanisms for monitoring and analyzing structural changes in the economy.

It is difficult to track and demonstrate even long established employment trends because the kinds of data collected by the Bureau of the Census, the Bureau of Labor Statistics, and other government agencies change over time. The way in which those data are aggregated or disaggregated, and the way they are labeled also change. The various bureaus and agencies differ, at any one time, in the way they define categories, so that their data often cannot be compared and the data from one agency cannot be used to augment and supplement, or explain, data from another agency. For example, cashiers may or may not be included with other clericals; "Federal employees" may or may not include postal workers and congressional employees; part-time workers may or may not be distinguished from full-time workers. Sometimes only a highly specialized data expert can disentangle employment data to address a simple question; some questions cannot be answered at all because data does not exist. It maybe impossible, for example, to determine when, and under what conditions, blacks entered office employment in significant numbers because no records of black/white employment were made until recent years.

What data is collected and how it is recorded depends, of course, on what questions one expects to address. At the present time, no Federal agency has a clear mandate, nor the available resources, to develop an indepth capability for economic and employment forecasting of the kind Congress and the executive branch will need in a future in which technological change will be continuing and rapid, and will have pervasive effects on all economic activities. Those agencies with primary responsibility for collecting economic and demographic

data have little capability, and few resources, for understanding advanced technology and the way it is likely to evolve in the future. The Federal agencies with the most highly developed knowledge of new technology, including computer technology, have no clear mandate, little capability, and few resources for analyzing economic and employment effects. Moreover, the primary government source of forecasts of commercial information technology, the institute of computer Science and Technology of the National Bureau of Standards, has recently suffered a severe cut in support of its planning and forecasting functions.

This indicates that the ability of Congress to be apprised of disturbing trends in office employment, or the broader area of whitecollar employment, should they occur, is not likely to improve in the future unless steps are taken to ensure that this capability is being developed within Government or that support is available for such research and analysis outside of the Government.

If it should become clear at some future point that white-collar employment is indeed not growing, or if there are signs of increasing structural unemployment, then Congress will need to consider interventions. At a minimum it may be necessary to take steps to assure that changes in employment opportunities do not differentially burden certain groups of workers, for example, women and minority workers. Workers in low-level *clerical jobs* may need special assistance in finding other employment. Steps may be needed to assure that there are entry level jobs for untrained workers, with on-the-job training opportunities.

Sometime within the next 15 years it could become necessary for Congress to take positive steps to deal with a declining number of office jobs or white-collar jobs, whether or not the economy as a whole remains strong. What steps are appropriate will, however, depend in part on whether there are available jobs *in* other employment sectors for which office workers may be retrained. The many strategies for consideration in responding to high levels of employment have not been a focus

of this assessment; they have been discussed many times in many places in continuing debates about long-range employment policy. They include "share the work" or shortened workweek strategies, strategies to stimulate economic growth and the creation of new industries, and strategies to ensure or augment family incomes. Most discussions of such policy actions in the past have focused on blue-collar unemployment. Their use to deal with white-collar unemployment would require careful consideration of the economic, social, and political conditions under which they would operate.

Conversion to Part-Time, Temporary, and Contractor Status

A large increase in the number of full-time jobs lost to part-time or temporary workers without worker protection mechanisms (perhaps Occurring due to office automation) could ultimately burden taxpayers or lead to degradation in the level of social well-being. If Congress chooses to intervene, it could constrain conversions of employees to other status by legislative confirmation of recent IRS rulings that an independent contractor accepting work from only one organization is in fact an employee; a mandatory minimum ratio between full-time and part-time or temporary employment; or mandatory pro-rating of benefits packages and social security contributions. Alternatively, Congress could alleviate some of the problems of involuntary part-time employment by further actions to encourage or require Voluntary Reduced Work Time arrangements, making involuntary part-timers eligible for partial unemployment benefits.

Training

Because continuing training and education are essential both to realize the productivity gains that office automation promises, and to alleviate undesirable effects on employment, Congress may want to consider actions to assist public school systems in planning and upgrading white-collar vocational training; encourage school systems and community col-

leges to provide retraining and continuing training programs; establish accreditation for commercial white-collar vocational schools; or direct the Departments of Labor and Education to develop guidelines for vendors and employers in designing training programs. Should there be signs of developing structural unemployment among clerical workers, Congress might then consider providing loans or other assistance to white-collar workers seeking training or retraining to move into other jobs and occupations.

Labor/Management

In general, the transitional problems involved in changing the technological base of an organization are best solved by the cooperative efforts of managers and workers in redesigning the work process and organizational structure. The public interest in this process is that of realizing the promise of increased productivity for the economy and encouraging fair play for those whose jobs and occupations will be affected. Because most office workers are not represented by unions, management has a particular need and responsibility to provide opportunities and mechanisms for involving employees in decisions about technology and its implementation. Given a minimal Federal role, Congress may wish to consider the desirability of educational or information programs for employers, employees, and their associations with regard to problems associated with office automation and strategies that organizations have successfully used for alleviating them. Other possibilities to be considered under some circumstances are clarification of worker rights under existing labor-management negotiation procedures, or changes in labor law to require worker involvement in technology-related decisions.

Health and Safety

In view of the concern about suspected hazards associated with computers and VDTS, options for Congress to consider include: 1) a public information program to inform employers and office employees about what is known

about the effects of office work on health and well-being, and what can be done to reduce visual and musculoskeletal strain and psychological stress; and 2) directing the Occupational Safety and Health Administration to develop ergonomic advisories, guidelines, or standards for use in public and private sector offices and in design of equipment and furniture used in office automation.

If these actions and self-initiated organizational management actions to alleviate these concerns are inadequate, then Congress may wish to consider legislation limiting the number of hours that workers can be required to spend continuously in VDT use.

In any case, because scientific evidence is still equivocal, and significant risks involved in computerized office work would affect a large proportion of Americans, Congress could support the funding of research on the relation of stress to chronic disease and illness and on the possibility of reproductive hazards related to VDT use. It may also wish to establish national mechanisms to monitor the health status of American office workers.

Data Security and Confidentiality

Previous actions to increase data security and ensure confidentiality in the handling of information about citizens have concentrated on risks from large centralized computer operations. Most organizations have been slow to recognize additional risks to confidentiality and security that come with decentralized computers. These risks are largely related to the increased access to organizational data banks; the portability of data storage media; and the lack of knowledge among general users about privacy laws, the principles of confidentiality, and established practices for safeguarding data. Information about clients, employees, and corporate resources and activities is subject to compromise or misuse. Organizations need to develop policies and practices that better protect the confidentiality and security of data that is processed or stored by small computers or other end-user devices.

Existing Federal privacy and security laws are largely designed to strengthen the ability of an individual to challenge the use of information about himself or herself. If lack of attention by organizations to data protection in decentralized computing leads to serious abuses, Congress may need to consider more stringent data protection laws, including liability for breaches of privacy and security.

Home-Based Clerical Work

Because this activity is already controversial, Congress may have to formulate policy regarding it within the next several years. Proposals have been made in Congress to provide tax credits for the purchase of computers for home-based work (and other nonrecreational uses). Other ways to encourage home-based work include legislative actions voiding IRS rulings and court decisions that make many home-based workers employees rather than independent contractors, and removal of other regulatory or tax barriers to home-based work.

However, Congress may instead wish to discourage home-based computer-mediated clerical work. It could then consider a ban on paid computer-related employment when the primary or sole work site is the worker's home, but would probably wish to distinguish this employment from similar activities designed to establish entrepreneurial small businesses. Congress may, instead, wish to clarify through legislation the conditions under which home-based workers are employees entitled to the normal worker protections afforded by law and equity, and to require pro-rated benefits for workers accepting work to be done in their homes.

Instead of banning or strongly discouraging home-based office work, Congress could insist on rigorous application and enforcement of existing worker protection laws and regulations to home-based work, including wage and hour laws, occupational safety and health regulations, and all applicable reporting requirements. This strategy would require

strengthening the resources and capabilities available to enforcement agencies.

Rather than banning or discouraging home-based work, Congress could adopt a strategy of increasing the range of employment options for workers through tax deductions or provision of day care centers; alternative means of caring for children, aged, or disabled dependents; and by further acting to increase mainstream employment opportunities for handicapped workers.

Off-Shore Office Work By or For U.S. Firms

The issue to be resolved here involves the desire for cost-saving for U.S. firms and economic development in Third World Countries v. the demand for preservation of clerical jobs in the United States. Congress may wish to encourage off-shore sourcing, which could be done by extending further technical assistance and information to interested companies in the United States and to development officials in prospective host countries, or merely by taking no action that would counter presently favorable market forces.

If Congress wishes, on the other hand, to discourage off-shore sourcing, it could do so through restrictions on data flow; additional privacy protection laws, requirement for more extensive security measures, etc.; regulations analogous to "local content" or "buy national" requirements; imposition of taxes or tariffs, such as value-added taxes or trigger price tariffs; limitations on the availability or use of dedicated telecommunications lines; or an outright ban on offshore sourcing.

Federal Procurement Policy

The present procurement policy for automating Federal offices has worked well, but there are some problems impeding further progress. Congress may want to consider asking the General Accounting Office and the Congressional Budget Office (CBO) to reexamine the effects of present procurement policies and regulations on the ability of Federal agencies to

procure state-of-the-art systems, and to plan toward integration and networking of Federal microcomputers and related devices.

Federal Personnel Policy

To assure that emerging effects of office automation are effectively managed, with full regard for the rights and interests of civil service employees, Congress may want to consider asking the Office of Management and Budget, the Office of Personnel Management, and CBO to conduct studies and prepare recommendations for changes in personnel recruitment, retention, job classification, and promotion and compensation policies to reflect changes in personnel needs, job content, and skills requirements resulting from office automation.

State and Local Governments

Federal policy is to shift responsibility for many decisions and programs to the local level. To handle these programs effectively and at the lowest cost to themselves, local governments need to increase office productivity. Small government units are lagging in automation. Congress may want to consider block grants to State governments for this purpose, direct technical assistance to small city and county government units, or other means of assisting small governments in office automation.

Small Businesses

Although there is a risk that small businesses will create fewer jobs if they are encouraged to automate their offices, this could be offset by increased viability and competitiveness, and enhanced opportunity to grow. Little is known as yet about small business office automation. Congress may wish to consider requesting a study from the Small Business Administration or other Federal agencies of the potential opportunities for and consequences of office automation in small businesses, especially with regard to their overall viability and their role in innovation, local economic development, and job creation. If addi-

tional evidence suggests that there is a public interest in assisting small business office automation, options to be considered include an information and education program for small organizations considering office automation, or specific technical assistance or financial loan programs for small businesses for the purpose of office automation.

Women and Minorities

If office automation reduces the number of office jobs, women and members of minority groups who have historically been disadvantaged in the job market, are likely to be most negatively affected. Congress may then wish to consider a series of steps to alleviate their disadvantage. It could:

- take explicit notice of these concerns and factors in discussion of bills concerning pay equity and comparable worth, which are now before committees;
- provide incentives for maintaining or improving ratios of female to male employment in labor force reductions associated with automation;
- provide incentives for maintaining the share of employment held by minority groups in office work; and
- provide subsidized child care facilities or increased tax deductions for child care to increase the employment options open to working parents.